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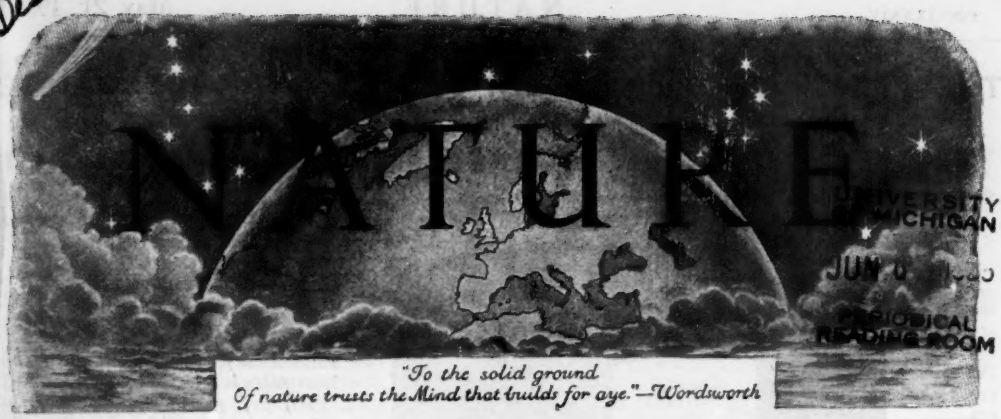

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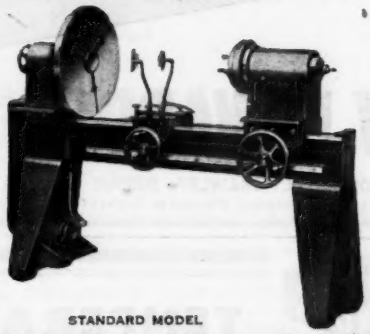

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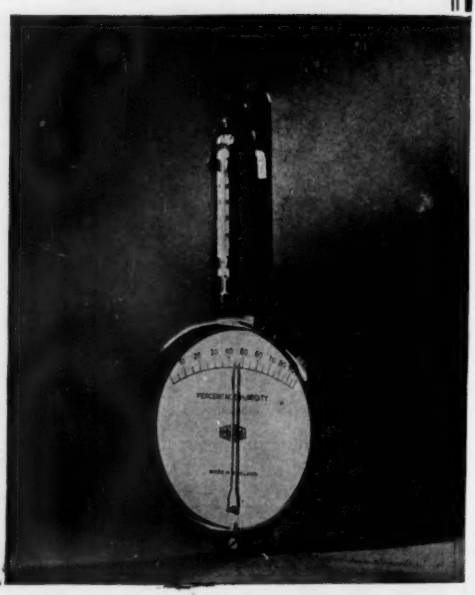

NATURE

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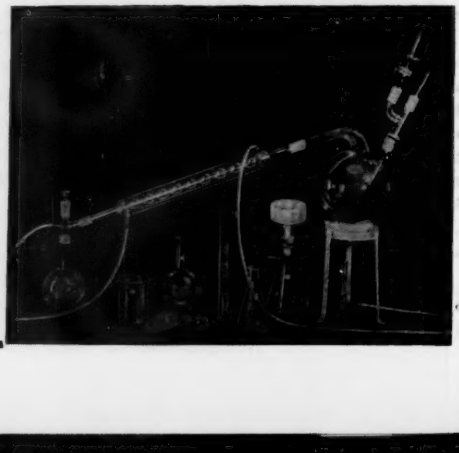

LEADERSHIP IN THE COAL INDUSTRY OF BRITAIN

THE report of the Advisory Committee, with Dr. A. Fleck as chairman, on the organization of the National Coal Board*, is a document of great interest to the scientist and technologist. In replying to a question in the House of Commons on the day of publication of the report, the Minister of Fuel and Power, Mr. Geoffrey Lloyd, said that there was a certain broad connexion between the report and his statement of February 15 on the development of nuclear power, and that the report indicated that there was a "real need for a technical and managerial renaissance in the coal industry to fit it to take its part in the atomic age". Besides the bearing of the report on the technological efficiency of the coal industry in Britain and the ability of that industry to take full advantage of technological advance, the report is also of great interest in relation to the administration of nationalized industry in general, and to the question of centralization and decentralization in any large-scale enterprise.

These are all matters that interest the scientist and may affect him closely; but he is even more closely concerned with the observations of the report on recruitment and training for the highest managerial positions in such large concerns. That in turn is a matter which touches closely on education for management in general, the balance between the faculties of science and arts in the universities, between universities and the colleges of technology, and kindred matters which have been constantly discussed of late in connexion with the expansion of higher technological education in Britain. Since the report was published, moreover, the British Institute of Management has published a report and recommendations dealing specifically with the recruitment and training of men intended for management positions†, while some of the discussions at the International Conference on the Functions and Education of the Chemical Engineer organized by the European Productivity Agency in London during March 21–23, in co-operation with the Institution of Chemical Engineers (see *Nature*, May 14, p. 842), were concerned with the place of the chemical engineer in management and administration, and with what could be done to enable him to make his full contribution to industrial productivity.

The Fleck Committee consisted of no more than five members, and was appointed in December 1953, beginning its work forthwith. Not the least merit of the report is the concise but clear statement of the position and size of the industry presented in the introduction; this should facilitate a better public understanding of how much has been done since the Board was set up in 1946, and thus eliminate some of the ill-informed criticism from which the Board has suffered in the past. So, too, the brief review of the needs and problems of large business undertakings, which precedes a note on the special problems of the nationalized coal industry, helps to supply a perspective for objective judgments and to correct the partisan approach which too often has darkened counsel.

The general criticisms made in this report do not necessarily apply to every department or to every part of the National Coal Board, although the weaknesses indicated are sufficiently widespread to warrant comment and to justify correction. The criticisms, moreover, do not detract from the considerable achievements for which the Board has been responsible in the face of difficulties to which the Fleck Committee can find no parallel in any other industry of which its members have knowledge. An organization for managing a thousand pits, previously run by eight hundred companies, was planned and brought into operation in a matter of months. The nine hundred collieries owned and operated by the Board in 1954 produced 212 million tons of coal. The financial turnover exceeds £700 million, and, besides 700,000 mine-workers, the Board employs 30,000 colliery under-officials and a further staff of 40,000. Not only is the industry widely dispersed, but also its secondary interests are varied, and some, notably the coking-plants, are vitally important.

The Fleck Committee puts the whole question of the National Coal Board and its organization fairly in the context of Great Britain's demand for fuel and power. The economic possibilities of nuclear energy are admittedly still uncertain, but ultimately are likely to change the pattern of our consumption of fuel and power. Meanwhile, however, for many years coal must continue to be the main source of supply, and a comparatively small amount of coal makes the difference between full-scale economic activity on one hand and a fuel crisis on the other. Much of the energy of the National Coal Board is concerned with this margin of output and with securing that some element of flexibility is brought into the fuel situation of the country.

This is largely a matter of management, and while the Fleck Committee considers that the present large-scale review of the Board's organization is well timed, it is no less emphatic that it should be the last of its kind for some time. It recommends indeed an immediate reorganization of the National Coal Board, which it believes should consist of a chairman and a deputy chairman, six other full-time members and four part-time members, the appointments to be so arranged as to ensure continuity and, among the full-time members, a sound age distribution. It recommends that in reconstituting the Board the Minister should give special attention to the necessity of ensuring that the members are able to work together as a team and that in future, before appointing part-time members, he should seek the advice of a body of leaders in particular fields; while before appointing a chairman or a deputy chairman,

* National Coal Board. Report of the Advisory Committee on Organisation. Pp. iii+105. (London: National Coal Board, 1955.) 2s. 6d.

† British Institute of Management. The Recruitment and Training of Men intended for Management Positions. Pp. 70. (London: British Institute of Management, 1955.) 5s.

he should be advised by the part-time members. These recommendations were accepted forthwith by the Government; the further recommendation that the salaries of the chairman and the other full-time members should be substantially increased has yet to be implemented, though the Board has undertaken to carry out as soon as possible a review of salaries at divisional headquarters "to make sure that they attract the best men to responsible positions there". The recommendation, however, is vital and is clearly one which, as the Fleck Committee does not fail to observe, engages the responsibility of the Minister and cannot be implemented without the exercise of his powers. Because there is nothing in the legislation under which the National Coal Board operates that prevents the industry being managed in accordance with the best commercial practice, or hinders the pursuit of much the same financial policy as a large commercial undertaking, it is imperative that the Board should be able to offer conditions of service competitively attractive to the appropriate talent at all levels.

On all this the Fleck Committee is emphatic. It recognizes that the industry managed by the Board is a very large amalgamation of units varying greatly in size and in the efficiency with which they were being managed immediately before the amalgamation. Much the same problems, however, confront all boards placed in charge of large amalgamations. To secure uniformly good management for the various units, to see that facilities for research and development are pooled, that there is a policy for standardization, that the best accounting and costing techniques are everywhere adopted, to establish for management new standards of performance and, perhaps most important of all, to establish confidence, loyalty and discipline among the management team—these are not tasks unique to the National Coal Board. They are the permanent tasks, demanding constant attention from the management, of any large industrial undertaking. A sound organization is essential; but it is the ability and integrity of the people working in the organization that count most.

The prime factor in success is the constant exercise of leadership at the highest level; and while the Fleck Committee emphasizes the importance of team-work, it leaves no doubt that decision and effective action at the top are also imperative to ensure that policy is implemented. It will be noted that the Committee insists that team-work must commence at the Board-level, and some of its most outspoken criticism is on this point. Equally it is emphatic that, in the main, the industry should throw up its own leaders, and the Board should pursue positive measures to that end. It is satisfied that the direction of the industry must be largely in the hands of men with experience in the industry, and that normally the industry should breed its own full-time board members; nor does the Committee see any reason why, given an appropriate staff policy, the industry should not throw up such men, capable of taking continuously a wide view on all the issues which the Board has to decide.

The Fleck Committee sees at this point, however, and not in the fact of nationalization as such, a prime cause of some of the difficulties of the British coal industry. From the end of the First World War to the end of the Second, the industry was starved of capital and of technical men. On nationalization it was, for the most part, backward in general and in technical management. The condition of many collieries was poor, and a wide technical renaissance, a large programme of physical reconstruction and greatly improved methods of management are required to enable the industry to meet the country's need for coal. Such a technical renaissance or reorganization will not by itself suffice. Organization itself cannot ensure the use of conciliation machinery in wage disputes, more regular attendance at work, or better discipline in the pits; and while the Fleck Committee recognizes that the Board itself should strengthen at all levels the calibre of the staff dealing with labour problems and adopt clear and resolute policies, it also points out that better leadership is required within the trade unions involved.

The recommendations which more specifically affect the scientist and technologist in the industry, as such, are to be found in the following section of the report, which discusses the headquarters organization of the Board; but they are more appropriately considered in the light of these general observations. In considering the composition of the Board itself, the Committee suggests that the Board's functions could be divided into six main fields: production; marketing and purchasing; industrial relations; staff; finance; and scientific. It proposes that responsibility for medical service should be given to the member of the Board responsible for scientific activities, and that each of these six fields should be the responsibility of a full-time member. It was satisfied that the present committee system works fairly well, though it suggests that the number and size of committees should be kept as small as possible, and it recommends that the system of organizing specialist staff in departments at each level of management should be maintained. For the industry to succeed, there must be leadership at all levels, and in particular leadership from the top. This means that the brains and ability concentrated at headquarters must be of the highest calibre, drawn from the most progressive elements in the industry. Only in this way can new ideas and a new outlook be inculcated throughout the organization.

The Fleck Committee is satisfied that, in the past, departments at headquarters have not always so consistently received the support which is their due and without which their task cannot be properly carried out; for this reason the Committee sets down in some detail its views on the way in which the functional channels should work. These are not indeed new or revolutionary and, as the Committee notes, have operated smoothly and efficiently in the better-run divisions and areas of the industry since the National Coal Board's organization was first established. It recommends specifically that the functional heads at each level of the organization should be of better calibre and higher status than

their functional counterparts at the next level below, and that this seniority should be openly acknowledged and reflected in remuneration. It does not recommend the establishment of a technical advisory service, but considers there is good reason for maintaining at headquarters, at division and at area-levels, specialists in various fields, and that the title 'Director-General' given to heads of existing departments should also be given to the executive heads of the new departments which should be established.

The great need of the industry, however, is better management at all levels, or, in other words, more people of ability, new and better techniques for them to use and firmer discipline; and in reaching this conclusion the Fleck Committee is clearly of the opinion that the industry for many years failed to get the share it should have had of the nation's brain-power and executive ability. While it has recruited from the mining departments of the universities at a level below the industry's needs, on nationalization it lost many of its administrators at a time when managerial and administrative talent were needed more than ever. The Fleck Committee believes that the decisions which the Board took at the outset about the main structure of the new organization were correct; but the consequent administrative and technical posts have not yet been filled by suitable people. Promotion has often been too rapid, and responsible posts are held by those with little knowledge of modern methods of management.

To help meet this situation, the creation of both a staff department and an industrial relations department is recommended; in these fields it is considered that the Board should seek the co-operation of the trade unions, as it does in such fields as safety, health and welfare, but it should not rely as heavily as in the past on the ranks of the trade union officials as a source of recruitment for responsible positions on this side of the Board's work. The Board should itself aim at training people for such positions, drawing largely on the whole body of its own employees. In particular, the Board should be at pains to fill the key posts concerned with personnel adequately, and to strengthen the staff wherever necessary.

The Fleck report suggests no changes in departmental responsibilities in the field of research and development; but it thinks that the present arrangements, under which responsibility for research lies with the Scientific Department and for development with the Production Department, should be broadened and strengthened by setting up a single Research and Development Committee in place of the existing two interdepartmental committees. The setting up of the Central Engineering Establishment should supply the necessary resources for development; but while the National Coal Board admits that the industry needs more development, of the recommendation to establish a Research and Development Committee it is only observed that "the way in which development can be continuously given the right stimulus is under consideration". The recommendation that divisional carbonization directors should be appointed is likewise still being considered by the new Board, on which Sir Charles Ellis, scientific member since it was formed in 1946, has been replaced by Dr. William Reid and Mr. A. H. A. Wynn.

A review of the organization of each divisional headquarters with the view of establishing a common pattern of organization and a re-assessment of the staff employed is also recommended, and likewise the laying down of a pattern of area organization which should be adopted by each area with only such variations as may be required by local circumstances. No changes are thought necessary in the size and number of areas. Fundamentally, however, what is required is more determination on the part of the Board itself to see that its policies are carried out, and the severest criticism in the report is to be found at precisely this point.

This is not so much a criticism of decentralization as of its execution, and of a mistaken conception of what decentralization means. Moreover, that mistaken attitude is not confined to the Board itself: it is to be found at all levels, and while the Fleck Committee points out that the Board must insist on its policies being properly carried out by the subordinate formations and ensure that proper discipline exists, the major obstacles arising from bad discipline and the failure to implement properly negotiated agreements are unlikely to be overcome without consultation and co-operation with the trade unions. It is a problem of size that is inherent in all large organizations, both in trade unions themselves and industrial undertakings in general. Causes of friction and misunderstanding can be minimized or removed by the clear statement of the principles of decentralization to be followed, the definition of the powers to be delegated and by greater boldness in making changes in personnel where necessary on account of age, inefficiency or indiscipline. The full effects of reorganization and full efficiency of the industry can only be achieved with the goodwill, understanding and full co-operation of all in it—Board, management and mine-workers—and with the guidance and leadership of the trade unions.

In his Cadman Memorial Lecture to the Royal Society of Arts last January, on research in the coal industry, Dr. W. Idris Jones described the direct representation of science at Board-level, by the initial appointment of Sir Charles Ellis as scientific member, as the most important single change effected by nationalization from the scientific point of view. The Fleck Committee clearly shares the view that the industry needs many scientists. From among these scientists as well as from others of the Board's employees will be drawn the future administrators and managers, including members of the Board itself.

Perhaps the most significant feature of the Fleck report, however, is not this demonstration of the need of the coal industry, or even of industry generally, for highly competent administrators and managers. The need of the National Coal Board for scientific and technical man-power is a factor of which full account must be taken in considering the supply and distribution of the nation's trained man-power. That demand cannot, and should not, be separated from

the demand for managerial and administrative talent in general, which to some extent must be met from technical and scientific sources. What stands out above all from this review of the organization of the National Coal Board is the demand made on management, not simply for technical knowledge and sound judgment, but still more for human understanding and for the moral qualities which leadership implies. Defects of leadership more than anything else appear to be at the root of the Board's difficulties in the past, and they are defects to be found not only at the Board-level but equally at area-level, in the collieries and in the trade unions.

This is not a position peculiar to the National Coal Board. It is equally true of transport and of industry generally, whether nationalized or privately owned. This need for leadership at all levels is a factor of which due account should be taken in recruitment and in the educational policy of Britain. A policy which provides means by which the able recruit entering at the lowest operative level can climb to board level if he possesses the requisite talent will fail of its full effect if, under the educational system, all such talent passes first to the university and enters the industry much higher up the scale. It may even be that the trade unions themselves are already missing talent for leadership which formerly would have come to them from the schools but now goes direct to the university. The indirect consequences of such a changing recruitment pattern can be extremely serious if no measures are taken to deal with the situation. On one hand, it emphasizes the importance of a wide general education which develops not simply technical competence but also human insight and sympathy and judgment. On the other, it points to the need for fostering public understanding of what science is and does, the conditions of technical advance and the functioning of industry, so that co-operation, goodwill and good industrial relations are more easily achieved. These are factors which bear closely on the recruitment and training of men intended for management positions. Little attention is given to such factors, however, in the report issued by the British Institute of Management. Nevertheless, the procedure developed for selecting and training recruits intended for such positions can contribute much to promoting within any firm the spirit of goodwill and understanding, and the climate of opinion upon which co-operation and good industrial relations are invariably based.

That needs to be remembered in any discussion on education for management, if not indeed in discussing technological or university education in general. A policy of recruitment for eventual management posts may be clearly defined, and effective steps taken to make all levels of staff aware of it and co-operative. Training courses may be provided for those selected, whether standardized for the external recruit until he specializes, or for internal nominees depending on their experience, and detailed for each individual in activities and dates for as long a period as practicable. Candidates may also be provided with a fair general statement of future prospects in the company and given early in their training a comprehensive picture of the organization and its policy, and due care taken in introducing them to each new department, advising them regularly and suitably and terminating the training period with a specific appointment. Such admirable recommendations of the British Institute of Management's Study Group will, however, fail of their full effect unless the education received by those selected for training has been such as to awaken responsiveness to human needs, to the structure and traditions of the society in which they move, and to encourage both vision and a sense of purpose in our civilization.

As Prof. W. R. Niblett remarks in his recent book, "Education and the Modern Mind" (Faber and Faber, Ltd., London), "if leadership is to be released . . . leaders must add vision to intelligence and will, but not merely that: they must be representative of their society, belonging to it profoundly. For unless they do thus belong, they will never feel intimately as disturbingly personal issues the conflicts really important in its life, and so will never be able to fight its battles within themselves". Prof. Niblett was concerned more specifically with the problem of making a school or university more deeply representative of the nation; but his words equally illumine the root problem of leadership, in the coal industry or in any other industry, and the factor with which, above all, training for management must be concerned. Unless leadership in this sense is released, and at all levels, no system of organization is likely to succeed. With it the size of an industry need prove no more obstacle to enterprise and efficiency than in the family concerns out of which large concerns have in the past so often emerged.

ETIOLOGY OF ANTI-SEMITISM

Working-Class Anti-Semite

A Psychological Study in a London Borough. By Dr. James H. Robb. Pp. xiv+239. (London: Tavistock Publications, Ltd., 1954.) 15*s*. net.

ANTI-SEMITISM is an ugly social phenomenon: it is also a very puzzling one. Those who have studied it most are still divided on the question whether it is to be regarded as a special case of race prejudice or as something unique, with a distinctive etiology.

"Working-Class Anti-Semite" is an important work because it contributes to an answer to this question. It is, moreover, the first large and well-conducted field-study of the problem to be carried out in Great Britain. Dr. J. H. Robb here reports the results of an investigation in the London Borough of Bethnal Green during 1947–49. After gaining useful background experience by serving as a part-time barman in a "local", he conducted an extensive series of interviews with a hundred or so randomly selected representatives of the working-class population. The purpose of these interviews had, of course, to be suitably disguised. Dr. Robb displayed quite remarkable ingenuity and skill in obtaining the information he desired through these informal doorstep conversations, and in reducing the raw data to terms which enabled statistical methods of some

precision to be used. He was able to assess his subjects for anti-Semitism and for a number of personality variables. He even persuaded a considerable number of them to submit themselves to a Rorschach test. His conclusions are based mainly on the data obtained from the two sub-groups representing respectively the extremes of prejudice and the extremes of tolerance. The members of these groups had mostly been subjected to longer interviews and to the Rorschach test.

Even his negative conclusions are important. No statistically significant relation could be found between anti-Semitism and either political allegiance or with experience of employment with Jewish employers or workmates. Nor was there any association of anti-Semitism with either residence in a Jewish neighbourhood, or with social class or "socio-economic status". These conclusions should at least help to deflect further research from the less to the more promising avenues of exploration.

Among positive findings, the first to be stated is that the level of prejudice in Bethnal Green is higher than is found elsewhere in comparable studies. This conclusion, though not unplausible, is not too well supported by the evidence adduced, and the statement out of its context could be exceedingly misleading. Detailed study of the facts reported leaves the impression that anti-Semitic prejudice in Bethnal Green is less pronounced than might well have been expected. The contrary impression would seem to depend on three shaky assumptions: that Dr. Robb's five-point scale can be equated to the scales used in other investigations; that the comparison can be made chiefly on the basis of comparing the percentage of tolerants; and that all the scales in question measure a single continuous variable.

The actual distribution of anti-Semitic opinion is seen in Table 7 of the work, which shows only 8·7 per cent to be extremely intolerant and 17·5 per cent at the extreme of tolerance; the three intervening steps are respectively 17·5 per cent in grade 2, 13·6 per cent in grade 3 and 42·7 per cent in grade 4. These figures suggest a bimodal distribution in which about one-third of the population distributes itself around the prejudiced mode and two-thirds around the mode of tolerance. Moreover, all figures have to be interpreted in the light of the author's statement that his rating scale tended to exaggerate the degree of intolerance shown.

The author's first conclusion, however, is much less important than the second, which is much better supported by the evidence—namely, that anti-Semitic prejudice is strongly associated with certain more general deviations from normality in the selected personality variables. The more extremely prejudiced differ from the more tolerant in ways that suggest that the former display a sense of insecurity, anxiety, an ambivalent attitude to authority and in traits which range from symptoms of neurosis to those of psychosis. Dr. Robb traces the syndrome in part to constitutional factors and in part to factors which condition development from infancy to maturity within the culture pattern of the Bethnal Green community.

His book retains some of the stigmata of the Ph.D. thesis—a rather too complete survey of previous research, too frequent apologies for not attempting the impossible, and rather over-detailed discussion of methodological niceties—but these are trivial defects in a work of such exceptional interest and importance. The importance is not entirely theoretical. The chief conclusions support the view that anti-Semitism is not an isolated phenomenon but is symptomatic of a more general condition of maladjustment. This makes it no easier to deal with; but there is consolation to be derived from the reflexion that whatever prevents or cures the development of anti-Semitic prejudice will also prevent or cure the development of many other disorders of personality.

C. A. Mace

LANDSCAPE OF BRITAIN

Man and the Land

By Prof. L. Dudley Stamp. (The New Naturalist Series: a Survey of British Natural History.) Pp. xvi + 272 + 56 plates. (London: William Collins, Sons and Co., Ltd., 1955.) 25*s*. net.

PROF. L. DUDLEY STAMP'S second contribution to the "New Naturalist Series" forms a fascinating sequel to his first, which was concerned with the geological evolution of the topography of the British Isles and with showing the influence of structure upon scenery; the present book deals with the influence of the hand of man in shaping the landscape as we see it to-day.

For two thousand years our scenery has undergone a gradual process of evolution while the land has been cleared of its natural vegetation to make way for man's crops and domestic animals, a process which has never stopped, and will continue. "Very little indeed of the scenery, even in the wildest and least touched parts of our islands, can be truthfully described as natural." Is man, then, always to be regarded as unnatural? Surely he is as much a part of the fauna as the other animals, in spite of his arrogance in setting himself above it: a newly established nesting colony of herring gulls, for example, can, by altering the local ecological conditions, change the scenery proportionately as much as a colony of men setting up a new suburb or airfield. There are, however, æsthetic standards for man, and, if he takes the trouble to think, he does know something of what he is doing. Evolution in scenery, as in all else, will go on whether man likes it or not: "our land is clothed with a living mantle and tenanted by living creatures. All living things are born, mature, decay, and die, to be replaced in due course by others which are different. However much therefore we may enjoy a particular phase of scenic evolution it is not a conversation piece to be framed and hung upon the walls of a museum or art gallery. It is alive, and our task is so to direct its growth that we create beauty, not destroy it. . . . So my story is the elimination of wild nature at the hand of man over the ages, and the gradual substitution of a landscape largely of his making, clothed with trees and plants of his choice, and tenanted by animals which he has either tended or tolerated".

Prof. Dudley Stamp surveys the whole history of the evolution of British topography since the end of the last glaciation some fourteen thousand years ago, and particularly since the arrival of neolithic man some seven thousand years ago. He deals with the influence of the early invaders, both before the Romans and after, and with the evolution of agriculture and husbandry; his chapters on the improvements in cropping and in the breeds of domestic stock are particularly interesting, as are those on the

introduced trees, plants and animals. His last two chapters on the gradual realization by man that the slow process of evolution under his influence was rapidly gaining speed under the pressure of expanding population, and that it might be going in a direction that would produce results not to his liking, are extremely important. They give a lucid summary of the legislative and other measures that have been taken in order consciously to influence this evolution, and point out how essential it is that we should know what we are doing and why. "The comprehensive land-use planning upon which we, as a nation, have embarked is doomed to fail unless we understand the present position and the factors which have led up to it." This is a splendid book, and the illustrations alone make one glad and proud to be a native of this green and pleasant land.

L. Harrison Matthews

THE PATHOLOGY OF CO-OPERATION IN INDUSTRY

Mental Health and Human Relations in Industry
Edited by T. M. Ling. Pp. xix+266+1 plate. (London: H. K. Lewis and Co., Ltd., 1954.) 21*s*. net.

THIS is indeed a worth-while book. Written at 'university level', it is in the best traditions of Elton Mayo's pioneer studies of the human and social problems of an industrial civilization, and, in British literature, is a worthy successor to the Eliott Jaques study of the Glacier Metal Company (reviewed in *Nature*, **169**, 85 (1952), under the title "The Anatomy of Co-operation"). The content of the book is in the main, to quote from Lord Horder's admirable foreword, "the record of Roffey Park, that significant experiment in social medicine".

There is no pretence at erudite analysis, no descent to the pseudo-mysteries of technical terminology. The editor and associate authors have accomplished the no mean achievement of presenting a simple and straightforward text-book study of the human animal's reactions to the social atmosphere in which he works, and in particular to the more unsatisfactory and negative factors in that atmosphere. "The very fact that people work together for a common purpose provides a complex situation that may be of benefit or of harm to its participants: human relations are promoted when such complex situations prove beneficial, and mental illness is probable where the 'climate' is persistently disharmonious". Lest the aim to contribute to the study of such subjects, within the universities, should appear to the layman to be academic, there is a useful and inter-related emphasis in both the first and the last chapters on the significance of such subjects to the man of practical affairs. "The University-trained engineers, economists or physicists often achieve positions where their technical skills and experience are subordinated to the use of social skills . . . [but] many of them have only a vague appreciation of the psycho-social problems which confront them" (Chapter 1). "Every manager and administrator, though often unaware of the fact, succeeds in the end through people . . . even the production of atomic energy must be planned by men and made through men's efforts" (Chapter 14).

Moving off from the foundation of a recapitulation of Mayo's observations on the social fragmentation and other ill-effects of rapid change inherent in the process of industrial advancement, the authors proceed to describe, explain and analyse the behaviour of the individual who is "perplexed by anxieties, apathy and withdrawal"—the manifestations appearing in inefficient working, absence, ill-health, careless work, strikes, and (when translated to the non-occupational environment) in communal difficulties and domestic disorders. "Neurosis," it is recalled from one research study, "is probably the largest cause of loss of working time in industry." Nor is this a deliberate creation of man's volitional cussedness—rather is it an essential by-product of his emotional and gregarious nature. Herein lies the true significance of this study as a contribution to training for management: not that managers are expected to become technically expert in the intricacies of social psychology, but they should be aware of the social problem inherent in their command of men and alive to its significance for their own executive behaviour and skill.

Chapter 4 is probably a pioneer in the annals of management literature—a review of "aggression in industry". "Aggression in one form or other often does, but need not, play a large part for ill in industrial relations; many of these ill effects could be avoided if as much study and discipline were used in the control of aggression as is commonly spent on favourite sports or hobbies." Basic to such control is the understanding of our own and other people's emotions. The following chapters consider constructively the patterns of behaviour that have to be interpreted in this process of understanding, and show how the ordinary manager can be assisted by the specialist services of personnel advisor or psychiatrist. In these directions the factual material that has been garnered from the harvest of Roffey Park's care, study and cure of several thousand 'patients' from industry makes its most valuable contribution. In Chapter 10 the threads begin to be drawn together in the plea for more attention to research in management practice: without research, whether on an operational basis or on the lines that Roffey Park's clinical facilities have provided, there can be no reliable knowledge of social disorders and their etiology, and thus no systematic approach to remedies. Nor can there be material for teaching.

To the practising manager this book will probably offer more than to the neophyte, because he will recognize in its every example a parallel to his own experience and a pointer to some of his own (unintended) failures; and in the simple schedule on p. 187 he will have basic articles of faith for his own and his subordinates' guidance, beginning with the dogma that "man is a social animal"—philosophically rational, but operationally emotional. It is here, perhaps, that the authors might have found a lesson from their own research: several of them are bothered whether management is "a science or an art". Had they recognized it more readily as "a process", they could have borne home more keenly the moral of the manager's own share in social emotional patterns that circumscribe his everyday work: "too often [the manager] fails", says one of the authors, "because he does not *feel* personally the issues involved: over-confidence produces blindness, and lack of confidence the loose rein". Ignorance, he might have added, produces the blundering command that sends many more than six hundred industrial casualties into metaphorical valleys of death.

E. F. L. Brech

RADIOLOGICAL HAZARDS FROM NUCLEAR EXPLOSIONS AND NUCLEAR POWER*

By Sir JOHN COCKCROFT, K.C.B., C.B.E., F.R.S.

Intensity of Radiation from Nuclear Explosions

THERE has recently been a considerable amount of discussion in Parliament and elsewhere on the biological effects of nuclear explosions. The greatest interest appears to be taken in the world-wide contamination which comes from test explosions. The most important source of contamination is the hydrogen bomb, since it produces 100–1,000 times more radioactive products than an atom bomb. The contamination is, however, of the same kind. The same radioactive fission products are produced and their activity decays in the same way. Thus the γ-ray intensity decreases by a factor of 50 between one hour after the explosion and one day. By the end of ten days it has decreased by a further factor of 20, and by a hundred days by a further factor of 10.

The explosion of a hydrogen bomb on the ground mixes millions of tons of soil with the radioactive products. Particles of all sizes from 1/50 in. diameter down to less than a thousandth of an inch are produced. These particles are transported by the wind. The larger particles fall out quickly. At Bikini they contaminated heavily a cigar-shaped area of the order of 7,000 square miles—220 miles long and about 40 miles wide. A large proportion of the radioactivity may come down in this local fall-out of the larger particles. The remainder of the radioactivity is carried into the stratosphere—above 50,000 ft.—and is carried on very fine particles. These are carried round and round the world, gradually spreading out and falling out slowly over a period of years.

Air-burst hydrogen bombs differ from ground-burst bombs in that practically all the radioactivity will go into the stratosphere and from there be deposited fairly uniformly.

In Great Britain we have monitored the contamination of the atmosphere by flights with aeroplanes carrying filters and by measurement of the radioactivity precipitated in rain water. From the aeroplane measurements we know that the intensity of radioactivity in the stratosphere arising from the explosion is very much greater than the activity at ground-level. From the rain-water measurements we can determine the amount of radioactive contamination which is deposited on the ground. We can then calculate an upper limit to the γ-radiation which is emitted by assuming that the radioactive products have not diffused far into the ground and that the radiations from them are not appreciably absorbed.

We find that the average concentration of radioactivity in the air at ground-level during the past three years due to bomb explosions of all types is about 1 per cent of the average natural radioactive dust content. The highest peak of activity was half the average natural level. The natural level itself fluctuates, and in some periods reaches fifteen times the average level. This is probably due to changes with meteorological conditions in the concentration of the natural radioactive gas, radon, which comes out of the ground. Prof. W. V. Mayneord has observed even higher fluctuations in London in special meteorological conditions, and these may be connected with the combustion of fuel.

Coming now to the radiation or radioactivity effects of bomb explosions on human beings, the accumulated dose which will ultimately have been received in Britain by completely unprotected people from the fall-out which has so far occurred is about 0·01 r. An additional dose will be received from the fall-out of the debris which is still airborne. This is expected to increase the total dose to 0·03 r. In the United States, where local fall-out from Nevada is important, the average dose received from bombs so far exploded will total 0·1 r. The actual dose varies by a factor of 2 in different areas.

It is important to note, however, that the radiation is strongly absorbed by brick houses, and in the lower part of a house the radiation-level is decreased about twenty times. Since the average person spends a good deal of time indoors, the dose received will be reduced by a factor of at least 10. The radiation will also be reduced by the washing of the radioactivity down drains and into crevices in the ground; the average dose in Britain is thus likely to be less than 0·003 r. over a generation. How small this is can be judged from the fact that natural sources of radiation in the ground, cosmic rays and the natural radioactivity of the human body give us each a dose of 3 r. over a generation of thirty years, and that in some parts of the world—such as Tibet—where the cosmic ray bombardment is more intense, the dose goes up to 5 r. without any very obvious effects. So our additional dose from bombs so far exploded is something like a thousand times less than our natural dose.

Genetic Effects of Radiation

I will now turn to the much debated genetic effects, speaking with diffidence as a physicist. The effect of radiation is to increase the natural mutation-rate of the genes responsible for transmission of hereditary characteristics. The mutations produced by radiation are identical with the naturally occurring mutations, which have widely varying effects, ranging from pre-natal death and serious malformation to minor disabilities, such as loss of fitness, personality defects and minor mental changes. For example, one troublesome natural gene produces about two thousand abnormalities of a particular type in our population. These mutant genes are transmitted from generation to generation as a genetic load of ill-health until they are eliminated by death before reproduction or failure to reproduce.

Dr. H. J. Muller, one of the leading geneticists of the world, considers that to double the natural mutation-rate generation after generation would produce disastrous results in a civilized population. In his opinion, it is advisable as a protective measure to limit the dose received before reproduction to a quarter of the doubling dose—so that the mutation-

* Address to the Parliamentary and Scientific Committee, delivered on April 20.

rate would not be increased by more than 25 per cent. It is probably fair to say that the opinion of geneticists would differ widely on the maximum permissible level.

The best evidence on the radiation dose required to double the natural mutation-rate in mammals comes from experiments with large doses of radiation on mice in the Oak Ridge Laboratory of the U.S. Atomic Energy Commission. These suggest a doubling dose of about 50 r. for mice. The extrapolation from mice to men is obviously an uncertain one. There is also a variation from gene to gene. If we accept Dr. Muller's criterion and apply the mice results to men, it would restrict us to a dose of 12·5 r. per generation.

I have said that from the bombs exploded so far the radiation dose received by most of us, shielded by houses and offices, will be less than 0·003 r. per generation. We are therefore several thousand times below Dr. Muller's maximum level and our additional dose from bombs so far exploded is perhaps a thousand times less than the dose we received from natural sources.

Other harmful effects of test explosions have been suggested in a recent communication by M. Charles Noel-Martin to the Paris Academy of Sciences. He suggested that a 20-megaton bomb could form 500,000 tons of nitrous oxide gas, leading to production of nitric acid and a harmful increase in the acidity of rain water. He also stated that a ground explosion of this magnitude would send up 1,000 million tons of matter and that this would appreciably diminish the transmission of solar radiation; and that enough radioactive carbon-14 might be formed to increase the natural radiocarbon content of the atmosphere by 10–30 per cent.

We have made some estimates of these effects at Harwell. American figures for the production of nitric acid by explosions suggest that M. Martin's figure is about ten times too high. The amount produced by thunderstorms every day is likely to be about equal to that for one hydrogen bomb explosion, so this effect cannot be important.

We have experience from the Krakatoa volcano explosion (1883) of a diminution of 10 per cent in the intensity of sunlight at the earth's surface due to the dust thrown into the atmosphere. This has been variously estimated at between 100 million tons and a figure 200 times higher. This great amount of dust had no effect upon the weather. Our own measurements of the amount of additional dust in the atmosphere due to nuclear explosions suggest that it is thirty times lower than M. Noel-Martin's estimates. The effect on solar radiation and weather must therefore be extremely small.

The radioactive carbon produced by a large thermonuclear explosion has been estimated at 300,000 curies. This will rise into the stratosphere and diffuse slowly downwards. The equilibrium amount will then be only one-thousandth of the amount naturally present in the atmosphere—produced by cosmic rays. Since the natural carbon-14 contributes only 1 per cent of the natural dose to the human body, the effect is negligible.

If we turn from test explosions to the radiological effects of a full-scale hydrogen bomb war, the picture is a very different one. A great deal of information has been released by the U.S. Atomic Energy Commission on the radioactive fall-out from the Bikini H-bomb explosion of March 1, 1954. The Commission has reported that an elongated cigar-shaped area down-wind from the explosion about 200 miles long by up to 40 miles wide was heavily contaminated by the radioactive fall-out. In an area 140 miles in length and up to 20 miles in width, the lives of all persons who did not take shelter would have been seriously threatened. For example, on one part of Rongelap Atoll, 110 miles away, the total dose in 36 hr. was 2,000 r.

Some distance farther from the point of detonation, at about 160 miles down-wind and along the axis of the ellipse, the amount of radioactivity would have seriously threatened the lives of about one-half the persons in the area who failed to take protective measures, that is, proper shelter from the radiation. It is estimated that the radiation dosage at that point was about 500 r. for the first 36-hr. period.

Near the outer edge of the cigar-shaped area and extending to approximately 190 miles down-wind, it is estimated that the level of radioactivity would have been sufficient to have seriously threatened the lives of 5–10 per cent of persons who might have remained exposed out of doors for the first 36 hr. In this area the radiation dosage is estimated at about 300 r. for the first 36-hr. period.

The Japanese fishermen at a distance of 85 miles from the explosion received a dose estimated by Japanese radiologists as greater than 100 r.

The Home Secretary has spoken in the defence debate on the consequences of fall-out for civil defence in Great Britain. Those living outside the areas destroyed by blast and heat but exposed to heavy radiation would have at once to seek shelter in houses or other buildings. Measurements carried out at Harwell have shown that an ordinary brick house would probably reduce the intensity of radiation by a factor of at least 20, while additional shelter can be provided by a cellar or slit trench. It has been said in the United States that an old-fashioned cyclone cellar with a covering of earth 3 ft. thick reduces the radiation intensity by 5,000. Having taken shelter, the occupants would have to stay inside until the radiation intensity had fallen to such a level that they could go out—at first for short intervals and then for longer periods. However, even after one week from the explosion, 36 per cent of the total dose has still to be delivered. In other words, in a zone contaminated so that the total long-term dose would have been 1,000 r., people coming out of shelter after one week for eight hours a day could still receive a long-term dose of 120 r. In these circumstances, a very large part of the population might receive more than the doubling dose. It is scarcely conceivable, however, that such an experience could recur in successive generations, and the genetic effect would seem to be a minor part of the overall catastrophe.

The world-wide contamination from a full-scale hydrogen bomb war can best be estimated by scaling up our estimate of the dose of 0·03 r. which would be received in the open in Britain from all bombs exploded so far. If the number of hydrogen bombs were to be 1,000 times the number so far exploded—which seems very unlikely—there would be a hemisphere contamination corresponding to a dose of about 25 r. This would be somewhat beyond Dr. Muller's danger-level if the experience were to be repeated generation after generation.

Before I leave this subject, I will try to dispose of another popular horror—the so-called cobalt bomb. There seems to be a general belief that still more lethal types of bombs could be produced by incorporating cobalt into a hydrogen bomb, and that such

bombs might poison the whole earth. Our studies lead us to the conclusion that there is nothing in this idea—the cobalt bomb would offer no advantages to a lunatic designer.

Radiation from Nuclear Power Development

The large-scale development of nuclear power from uranium fission will necessarily produce large amounts of radioactive waste products having properties identical with those produced in nuclear explosions. The radiations are, however, mainly confined to the nuclear reactors which are the source of heat for nuclear power stations, and to the chemical plants where the radioactive wastes are extracted from the spent uranium fuel.

The radiation in the vicinity of the nuclear power units can be kept below the internationally agreed safe levels without difficulty by the use of suitable shielding. The average radiation dose received by Harwell workers is 0·25 r. per annum. This is one-sixtieth only of the level agreed internationally as permissible for workers employed in such circumstances. The chief hazards at Harwell so far have been the usual type of industrial accident.

The public health problems are thus largely transferred to the chemical processing plants. The radioactive waste products include radioactive gases, such as radiokrypton and xenon; these are at present allowed to escape from the processing plant in conformity with safety regulations, providing that no harm can be caused to the neighbourhood. It is likely that in future they will be bottled and turned to useful purposes. The emission of gaseous wastes will not increase to any significant extent as we develop the atomic power programme.

The radioactive solid wastes can be divided into three groups, only one of which presents a serious problem. The first group contains those isotopes which are only slightly radioactive; these are comparable to the natural radioactive elements of the earth's crust, and dispersal is a satisfactory method of dealing with this group. The second group consists of the great majority of the radioelements produced in fission, and these decay fairly rapidly. Storage of this group, for a period of say ten years, would reduce the activity to a level at which dispersal would be practicable and completely safe.

The third group is the one which presents difficulties. It consists essentially of two elements, strontium and cæsium. Each of these has an isotope which decays moderately slowly, so that dispersal would only be possible after an unreasonably long storage period (hundreds of years). These two isotopes are finding increasing use in industry and medicine, and it appears there will be a commercial market for all available quantities of them for the next few years. Chemical separation of these isotopes will enable the Atomic Energy Authority not only to dispose of the first two groups without difficulty but also to market a valuable by-product.

It will, of course, be necessary to apply the same standard of radiation protection as has been adopted in the Atomic Energy Authority. By the time the supply of strontium and cæsium exceeds the demand, the methods of permanent storage of these isotopes, on which work is proceeding vigorously, will have been fully worked out. The present safe procedures of disposal at sea and of long-term storage may still be valuable for a small amount of certain types of high-activity waste; but it is probable that newer methods will supersede them. The problems of radioactive wastes in the atomic power programme seem likely to be solved by the technological developments now in hand.

General Conclusions

The level of radioactive contamination in the world produced by all the nuclear bomb explosions and peaceful atomic energy activities is at present so low that it should not cause any anxiety. The radiation-level which would give rise to serious harmful effects it probably at least a thousand times the present level of contamination. We do not at present know this figure with any accuracy, and long-term genetic studies are required to determine this. A Committee of the Medical Research Council has been formed to investigate these problems; this will in due course produce a better assessment of the position than I have been able to do here.

BIOCHEMISTRY OF VITAMIN B_{12}

THE latest of the valuable series of symposia arranged by the Biochemical Society had as its topic the biochemistry and functions of vitamin B_{12}. This truly remarkable substance was isolated only seven years ago. Its close connexion with a mortal disease of man and its importance in animal nutrition fired the interest of workers in many laboratories, and progress in its study has been encouragingly rapid.

Dr. E. Lester Smith (Glaxo Laboratories, Ltd.), the first speaker, reviewed the isolation and chemistry of vitamin B_{12} and described the unravelling of its structure, in which the Glaxo workers so fruitfully joined hands with Sir Alexander Todd's group in Cambridge and Dr. Dorothy Hodgkin in Oxford. He recalled the fascinating story of how he and his colleagues almost simultaneously with the Merck group in the United States produced the crystalline vitamin from liver, which contains only one part of it per million, with only clinical tests as guide. Liver is now entirely uneconomic for large-scale preparation. Commercial production is by fermentation, and the vitamin comes either from spent liquors in the manufacture of streptomycin and aureomycin or is made by a variety of micro-organisms in special fermentation. Dr. Smith outlined some of the steps of its isolation from such materials, in which chromatography plays an important and essential part.

The molecular weight of cyanocobalamin (vitamin B_{12}) is about 1,350 for the anhydrous substance, and the empirical formula lies within the limits $C_{61-64}\ H_{84-92}\ O_{13-14}\ N_{14}\ P\ Co$. The cyanide group attached to the central cobalt atom may be replaced by other acid radicals, giving rise, for example, to nitritocobalamin (vitamin B_{12c}) and hydroxocobalamin (vitamin B_{12b}). Hydrolysis with warm acid splits off the characteristic 'nucleotide', 5 : 6-dimethyl-1-(α-D-ribofuranosyl) benziminazole-2′ (or 3′) phosphate, the rest of the molecule being the naturally occurring factor B, the parent substance of the whole family of vitamin B_{12}-like factors so far described, more fully considered by the next speaker. Hydrolysis of vitamin B_{12} with cold 2*N* hydrochloric acid in the presence of nitrite leads to the formation of a series of red carboxylic acids containing one to six acidic groups and still retaining the nucleotide,

and of another series of seven orange-coloured acids that have lost the nucleotide (that is, are derived from factor B). Of factor B itself and its derivatives, only the hexa acid has yet been crystallized, and it is this compound that proved so useful in further crystallographic study. The hydrolytic procedures reveal the presence within the vitamin B_{12} molecule of six $CONH_2$ groups, the nucleotide attachment being provided by a seventh, D$_g$-1-aminopropan-2-ol forming the link, with the amide at one end and phosphoric ester at the other. The second phosphoric acid hydroxyl is accounted for by attachment to ribose. Consideration of the properties of the molecule leads to the concept that the third hydroxyl is masked by internal salt formation in vitamin B_{12} itself, the centre co-ordination complex in it being basic and neutralized by the phosphoric acid group on the rest of the molecule, a configuration supported by X-ray crystallographic examination at Oxford.

The crystallographic approach has proved astonishingly fruitful and has yielded a deep insight into the structure around the cobalt atom; this is almost that of a porphyrin, the difference being that in vitamin B_{12} two of the four rings are directly linked without any bridging atom. As pointed out by Dr. Dorothy Hodgkin in the discussion, X-ray crystallography indicates that this inner nucleus is attached to a system of acetic and propionic acid residues. The usefulness of the X-ray work is further demonstrated by its fixing the point of attachment of the phosphate to the third position on the ribose chain.

The introduction of labelled atoms into vitamin B_{12} is of great value in analytical, microbiological and, especially, clinical work, and Dr. Lester Smith described the preparation for hæmatological studies of vitamin B_{12} labelled with all four available radioactive isotopes of cobalt.

Dr. S. K. Kon (National Institute for Research in Dairying, Shinfield, near Reading) described other factors related to vitamin B_{12}. Examination of natural materials that have undergone microbial fermentation, such as rumen and gut contents, fæces, silage and the like, by methods similar to those used for the isolation of vitamin B_{12}, reveals in them the presence of red, cobalt-containing pigments closely related to vitamin B_{12} but differing from it in microbiological activity and, with one exception, absence of growth-promoting properties for animals. Through efforts of workers at Shinfield and at Glaxo Laboratories, of Wijmenga in Holland, of Pfiffner in the United States, and of Bernhauer in Germany, some ten such substances have been separated and six so far characterized in reasonable detail. One of these is factor B, and the other five differ chemically from vitamin B_{12} only in the nature of the nucleotide. Thus, in pseudovitamin B_{12}, adenine instead of 5 : 6-dimethylbenziminazole is the nitrogenous base. Factor A contains 2-methyladenine, a purine hitherto not encountered in Nature, and factors G and H contain respectively hypoxanthine and 2-methylhypoxanthine. The base of the fifth factor, vitamin B_{12}III, which also yields factor B on hydrolysis, is not yet known, though it is probably not a purine derivative. Vitamin B_{12}III is the only naturally occurring vitamin B_{12}-like factor so far tested found to be active in pernicious anæmia. Though they may have no direct function in the animal, their microbiological activity indicates that these vitamin B_{12}-like factors may be important metabolites for micro-organisms, necessary, for example, for the proper functioning of the rumen or gut flora. The Shinfield workers were able to prepare factor A and pseudovitamin B_{12} in guided biosynthesis by offering factor B and the corresponding nitrogenous base to a *Bacterium coli* mutant; and with substituted purine compounds and with benziminazole derivatives they obtained in this way a series of new, 'unnatural' analogues of which the monomethylbenziminazole, and the benziminazole one also obtained by Fantes and O'Callaghan by adding *o*-phenylenediamine during fermentation of *Streptomyces griseus*, were of particular interest because of their activity for higher animals mentioned later on in this summary article. 9-β-Ribose derivatives of adenine were not incorporated, in agreement with Dr. Hodgkin's statement that only 7-α-derivatives would fit into the molecular structure of vitamin B_{12}. The biosynthetic approach opens up possibilities of production of vitamin B_{12}-like factors with vitamin or antivitamin function.

In a joint paper, Dr. M. E. Coates and Dr. J. E. Ford (National Institute for Research in Dairying) considered the methods of measurement of vitamin B_{12}. Physical and chemical tests are insensitive and non-specific, but have a limited application in the control and standardization of manufacture. Some of the microbiological techniques are susceptible to interference by vitamin B_{12}-like compounds; but as these are present only in traces in animal products, care in the selection of the method has to be exercised mostly with substances that have undergone bacterial fermentation. Of commonly used test organisms, only the protozoan, *Ochromonas malhamensis*, resembles the higher animals in its pattern of response to the B_{12}-vitamins. In the preparation of extracts for the microbiological assay, the addition of traces of cyanide not only facilitates extraction by displacing protein or peptide groups originally linked to the vitamin, but also converts the B_{12} compounds to their stable cyano forms.

In the biological assay of vitamin B_{12}, it is necessary to deplete the reserves of the test animals either by restricting the vitamin B_{12} intake of the dams or by imposing on the animals themselves stress factors in the diet. The chick is more suitable for the assay than the rat; but both may over-estimate the potency of crude materials containing unidentified growth factors unrelated to vitamin B_{12}. The presence of vitamin B_{12}-like compounds is less likely to complicate animal assays, since, of the naturally occurring ones, only vitamin B_{12}III is active, and that only to the extent of one-twentieth of the activity of vitamin B_{12}. The 'unnatural' benziminazole analogue of vitamin B_{12} is, however, one-third as active as vitamin B_{12}. (The monomethylbenziminazole analogue has since proved more active than the benziminazole one.)

Although biological methods give a measure of the physiological availability for the test species, there is evidence that some of the naturally occurring bound forms of vitamin B_{12} may be poorly utilized by animals unrelated to the species from which the binding factor originates.

Drs. D. L. Mollin and S. J. Baker (Department of Pathology (Hæmatology), Postgraduate Medical School of London) considered the absorption and excretion of vitamin B_{12} in man. The introduction of radioactive vitamin B_{12} has simplified the diagnosis of the various vitamin B_{12} malabsorption syndromes and has led to the development of methods of study of absorption and utilization of vitamin B_{12} in health and disease. In this connexion the short-lived

isotopes of cobalt, cobalt-58, -57 and -56, have been specially useful, since vitamin B_{12} labelled with them can be given repeatedly and at high specific activity. The uptake of vitamin B_{12} is determined by measuring the amount of a test dose excreted in the fæces, or, more simply but rather less accurately, in the urine; and in this way the effect and the activity of intrinsic factor preparations can be studied. The excretion method can also be combined with direct measurement of hepatic storage by applying a directional scintillation counter over the liver. By all such studies, linked with the microbiological assay of vitamin B_{12} in the serum, the earliest stage of vitamin B_{12} deficiency can be established and the causes of the deficiency can be separated from its effects. Until, however, accurate methods for measuring the absorption and utilization of folic acid are also available, the pathogenesis of the megoblastic anæmias in man will be only imperfectly understood.

This paper was followed by one by Dr. A. L. Latner (Department of Pathology, Royal Victoria Infirmary, Newcastle) on the intrinsic factor. After reviewing Castle's classical experiments that led him to the definition of the intrinsic factor, and the methods of preparation and assay of active concentrates, Dr. Latner described his preparation from human gastric juice and from the gastric mucosa of the pig of a clinically highly active mucoprotein with a molecular weight around 17,000. This mucoprotein formed a complex with vitamin B_{12}, containing far less cyanocobalamin than would be expected on a 1:1 molecular basis. Dr. Andresen in Denmark prepared a complex of the same order of activity as Dr. Latner's mucoprotein but of a molecular weight around 70,000, and it seemed possible that the vitamin in the complex was acting as a cross-linkage between several molecules of the intrinsic factor. Work done in Dr. Latner's laboratory on the fæcal excretion of vitamin B_{12} by normal and gastrectomized rats produced evidence for a species specificity of intrinsic factor.

Dr. H. R. V. Arnstein (National Institute for Medical Research, Mill Hill, London) discussed the function of vitamin B_{12} in animal metabolism. Of all the metabolic reactions in which its function has been suggested, only the biosynthesis of methyl groups is known with certainty to be affected by vitamin B_{12}. Dr. Arnstein's studies indicate that vitamin B_{12} probably acts in the metabolic formation of these groups from serine, glycine and formate. When these compounds, labelled with carbon-14, were given to vitamin B_{12}-deficient rats, the incorporation of the labelled carbon was 60–70 per cent greater in the presence of vitamin B_{12}. Dr. Arnstein suggested that the site of action may be in the formation of an intermediate, such as hydroxymethylhomocysteine, in methionine synthesis, or perhaps in the reduction of such a hydroxymethyl to a methyl group. Experimental evidence shows that vitamin B_{12} is not involved in direct transmethylation, or in the interconversion of serine and glycine, which requires folic acid and pyridoxin. Vitamin B_{12} also brings about increased synthesis of choline from methionine by its effect on the *de novo* synthesis of methyl groups. The influence of vitamin B_{12} on synthesis of methionine and choline is only indicative of other and more important metabolic functions, still imperfectly understood.

In the last paper, Drs. J. Lascelles and J. Cross (Department of Biochemistry, University of Oxford) reviewed the function of vitamin B_{12} in micro-organisms.

The vitamin has been shown to act, directly or indirectly, in numerous metabolic processes within the cell. Species of *Bacterium coli*, some with an induced requirement for vitamin B_{12}, have been extensively studied. The evidence points largely to the conclusion that, in this group, the vitamin operates fundamentally in the synthesis of methionine, most probably at the stage of methylation of homocysteine; but the precise mechanism by which the vitamin acts is still obscure.

In a second group of micro-organisms, represented by *Lactobacillus leichmannii*, the vitamin has been identified with the synthesis of deoxyribosides. Methionine is needed for growth, even in the presence of the vitamin.

The functions of vitamin B_{12} are evidently closely interconnected with those of 'folic acid', though the two probably act at different levels in biosynthetic reactions.

In certain *Chrysomonads*, and in a species of *Flavobacterium*, the requirement for vitamin B_{12} is only partly satisfied by methionine, and it is clear that the vitamin functions in micro-organisms in other processes apart from the formation of methionine and nucleic acid derivatives; but there are still no firm indications of what these are.

The general impression conveyed by this stimulating symposium was that, for the time being, the art of the chemist in unravelling the complicated structure of a remarkable substance has outstripped the efforts of physiologists and biochemists in defining the fundamental synthetic process that may well underlie the present diversity of known functions.

RESEARCH INVESTIGATIONS OF THE CENTRAL ELECTRICITY AUTHORITY

By Dr. J. S. FORREST

Director of Research Laboratories, Leatherhead, Surrey

OPINIONS differ as to the extent to which users, in contradistinction to manufacturers, should engage in research; but so far as the Central Electricity Authority is concerned, the question is settled by the 1947 Electricity Act, which states that "it shall be the duty of the Central Authority to conduct research into matters affecting the supply of electricity".

The Authority's research activities can be broadly classified into three groups: (*a*) research carried out by the Authority and area boards; (*b*) co-operative research under the ægis of a research association or in conjunction with manufacturers or other users; and (*c*) research carried out for the Authority by universities or other organizations.

The way a particular problem is dealt with depends broadly on the nature of the problem and the prospects of finding an early solution. Thus the work carried out directly by the Authority in its laboratories and power stations arises mainly from specific operational problems to which an answer is required in the shortest possible time. Problems of more general interest to both manufacturers and users are referred to the appropriate research association.

Fundamental work, which is not expected to lead to any immediate practical applications but which may in time have far-reaching effects, is done mainly at universities, and research contracts are placed on the advice of the Authority's Research Council, with the university department which may be willing, and is best fitted, to carry out the work.

It should be emphasized that no attempt is made to plan research in detail, and in practice the organization of the Authority's research programme is very flexible, so that changes in the scope of the work can easily be catered for and full advantage taken of the research staff and facilities available from time to time.

A few examples of the work in progress in the fields of generation, transmission, distribution and utilization of electricity will give a better idea of the scope and organization of the Authority's research work. It must be emphasized, however, that in a short article only a few of the main researches can be mentioned, and it is not possible to do justice to much of the interesting work carried out by many of the government establishments, research associations and universities of Great Britain on behalf of the Central Electricity Authority.

As is well known, thermodynamic laws and the limitations of existing materials set an upper value to the thermal efficiency of generating plant. Steady progress has been made, however, and modern stations have thermal efficiencies greater than 30 per cent, which is much higher than that of many other kinds of energy-converting plant. However, an efficient station is an expensive luxury if it is frequently out of service, and for this reason an important part of the Authority's research is devoted to the improvement of reliability or 'availability'. Boiler plant has sometimes to be taken out of service as a result of deposits which build up on the fire side of the heating surfaces to such an extent that the gas passages are blocked and the boiler has to be shut down and cleaned. The rate at which the deposits form depends on the combustion conditions in the furnace and on the presence of certain elements, such as sodium, potassium, sulphur and phosphorus in the coal. By studying such factors, methods of improving the availability of boiler plant are being continually developed. For example, at one station modifications were made which enabled the boilers to steam for 3,000–4,000 hr. instead of 500 hr. An improvement in boiler output was also obtained. Furthermore, at another station the availability of a 525,000 lb./hr. slag-tap boiler was increased from 400 hr. to one year by selecting the fuel on the basis of research into the constituents of coal responsible for fouling.

Internal corrosion is another major problem of boiler plant, and research is also in progress on the conditions inside the boiler tubes. This problem is being tackled by studying statistical data from boilers in service, and also by investigating the corrosion of boiler tubes at high temperatures and pressures in the laboratory.

In modern boiler plant, the coal is ground to a fine powder and the resulting 'fly-ash' consists of very small particles which would cause a nuisance if allowed to escape from the chimney in large quantities. Research is therefore being carried out on grit-collecting devices, and in particular, on electrostatic precipitators. For this work two pilot electrostatic precipitators have been built, so that the behaviour of different kinds of dust can be studied under various conditions of voltage and current. This work is leading to a better understanding of the mechanism of electrostatic precipitation and should ultimately provide more efficient and more economical methods of dust collection. Even at the present time, precipitators installed at modern power stations are removing 98 per cent of the dust from the flue gases. The size of the dust particles, their density, and in particular their free-falling speed in air, are important factors in the collection and dispersal of the dust; accordingly, apparatus has been developed for grading dust samples in terms of these factors. Having collected the fly-ash, the problem of its disposal or, if possible, utilization remains, and research is in progress in several laboratories on uses of fly-ash for making bricks or building blocks, as a partial replacement for cement in concrete, a light-weight aggregate, or a filler for asphalt roads.

A power station of moderate size (200,000 kW.) requires 10 million gallons of cooling water per hour; it is not surprising that an operational requirement of this magnitude leads to some problems and provides scope for research. An experimental cooling tower has been built for research on water cooling, and work carried out with this apparatus has led to improved methods of calculating cooling-tower performance, and also to the development of a successful device for preventing the precipitation of moisture in the vicinity of cooling towers. In the laboratory, work is in progress on heat transfer in condensers and on the effect of surface films on the condenser tubes.

The inherent limitations in the steam cycle have already been mentioned, and scientists have for more than a century been looking for fundamentally more efficient energy-converting processes—in particular, they have been attracted by the possibility of turning the chemical energy of a fuel directly into electricity by means of a 'fuel cell'. It is clear that formidable difficulties must be overcome before a practical fuel cell on a sufficiently large scale to make a useful contribution to the electricity supply of Great Britain can be realized. Nevertheless, the Authority feels that it is worth while to sponsor research in universities and other organizations on various types of fuel cell. Even if the main object is not achieved, the by-products of such a research often justify the effort.

The present national peak load is about 17 million kW. and is still increasing at an average rate of about 7 per cent per year. Plans are already being put into operation to supply a peak load of 30 million kW. Coal is becoming more difficult to mine, and the hydro-electric resources of Britain can supply only a few per cent of our requirements. It is clear that the only practicable alternative to the chemical energy of coal is nuclear energy, and the Authority has therefore been working in collaboration with the Atomic Energy Research Establishment (now the Atomic Energy Authority) for some time in order to foster the development of nuclear power stations. The stations envisaged at present will use the heat produced by fission to generate steam for a conventional power station; but here again the possibility of converting nuclear or atomic energy directly to electrical energy should not be overlooked.

It is seldom that the load centres are geographically close to the sources of energy such as coal-fields or waterfalls. Furthermore, considerable economies in spare plant can be made by interconnecting generating stations. For both these reasons it is

necessary to transmit electrical energy over long distances by means of high-voltage transmission lines. Transmission lines are now operating in Britain at 275,000 volts—such a line can transmit 300,000 kW. over a distance of 200 miles at an efficiency of 95 per cent. Although electrical power transmission practice has reached a high standard, there still remains scope for research with the objects of increasing reliability and reducing cost. At these high voltages, corona discharges may occur on the surface of the conductor as a result of the high electrical stress; this causes a loss of power, the amount of the loss depending on the size of the line conductor and on the weather. Research on corona and other high-voltage problems is carried out on an experimental transmission line at Leatherhead which can be operated at voltages up to 400,000.

The insulation of high-voltage transmission lines presents many problems, particularly in industrial or coastal districts where moist deposits on the surface of the insulators may cause electrical breakdown. Research on the behaviour of insulators under such conditions has been carried out at the Croydon Testing Station for many years. This work has led to a better understanding of the mechanism of insulator breakdown and to the development of improved insulators.

Other aspects of electrical insulation are also of great importance, and work is in progress on insulating materials for switchgear, transformers and cables, again with the objects of improving reliability and reducing cost. Better methods of testing insulation are being developed in the laboratory and applied in service; in this way many serious breakdowns are prevented by detecting and replacing faulty insulation at an early stage.

Research is also in progress on insulating liquids, such as the mineral oil used in transformers and switchgear. The efficacy of anti-oxidants in prolonging the life of the oil is being studied, both in the laboratory and in service.

Lightning is one of the commonest causes of breakdown of overhead transmission systems, and electricity supply authorities in many countries have fostered research on methods of preventing breakdown due to lightning. This research is carried out in co-operation with many organizations in Britain and overseas, and also in the Authority's laboratories, where a 1·4 million volt surge generator is used to investigate surge protective devices and the ability of equipment to withstand high-voltage surges.

Overhead lines are exposed to all weather conditions and are expected to have a life of at least twenty years. It is important, therefore, that corrosion should be prevented so far as possible and, with this in mind, samples of the steel-cored aluminium conductors of the British Grid transmission system have been examined in the laboratory at intervals during the past twenty years. This work has shown that there is some deterioration due to corrosion, particularly in industrial and coastal areas. The causes of various types of corrosion have been elucidated and methods developed of preventing corrosion on new lines by impregnating and coating the conductors with a suitable grease.

As an example of research on methods of utilization, the investigations which are being made on district heating, heat pumps and electrical space-heating may be mentioned. In particular, several interesting installations with electrically warmed floors have been equipped with instruments which will give a detailed record of the weather conditions, the temperature inside the building and the electricity consumption. In this way, objective data will be obtained on the economics of this method of heating, which has the great advantage of making use of the heat-storage capacity of the floor and also of saving the wall space which would otherwise be required for radiators.

OBITUARIES

Prof. D. T. Barry

Prof. David Thomas Barry, emeritus professor of physiology in University College, Cork, was born at Ballyanihan, about thirty miles north of Cork city, in the year 1870. He studied at Queen's College, Cork, graduating M.B. (R.U.I.) in 1894. He first practised in Birkenhead as assistant to an Irish doctor, Dr. Browne, and later on his own. He continued study at the University of Liverpool, where he found physiology of increasing interest. After some years, he handed over his practice to a younger brother and went to London, where he was associated with Starling. Later in Germany he worked with Waldeyer and Kopsch. Barry obtained the M.D. (R.U.I.) in 1903, the diploma in public health (Liverpool) in 1904, and the fellowship of the Royal College of Surgeons (England) in 1907. The same year, on the invitation of the late Prof. Windle, he accepted the chair of physiology at Cork—a post he held for thirty-four years. Before his appointment, physiology was taught as a side-line of anatomy. Barry soon changed its status in the College curriculum. New laboratories were erected and physiology became a separate department which eventually embraced histology and biochemistry.

Barry directed the Physiology Department in Cork, spending about seven months of the year there and the remainder in Paris. His work interested Dr. A. Chauchard, of the Laboratoires Maritimes de Dinard. Through this friendship, Barry made many contacts. He worked with Gley (Collège de France), Richet (École de Médecine) and Lapicque (Faculté des Sciences, Sorbonne). He also worked at the Institut Marey, Boulogne-sur-Seine. The French Government awarded him the title of Chevalier de la Légion d'Honneur in 1929. In Paris he made the acquaintance of a French lady—Miss Yvonne Boriet—daughter of a French architect and herself a distinguished artist; their marriage influenced his career, as he continued to share his time between Cork and Paris.

Barry's researches were extensive. His publications are mainly connected with cardiac perfusion and related topics, and he was a pioneer in cardiography. Most of his communications are in the *Journal of Physiology*, *Lancet*, *American Journal of Physiology*, *Archives Internationales de Pharmacodynamie*, *Comptes rendus de la Société de Biologie* and the *Irish Journal of Medical Science*.

At Cork I found Barry a delightful colleague, and his help was always freely given. I was fortunate to co-operate with him in a research on the absorption of polysaccharides obtained from the breakdown of glycogen, published in the *Bulletin de la Société Philomatique de Paris*, 1932. A colleague described Barry years ago in these words: "Superbly endowed with degrees, he was a source of inspiration to his

students. To hear D. T. Barry talk about the central nervous system, to watch him draw cross-sections of the brain and cord at different levels, to see him doing heart–lung perfusions, demonstrating the electrocardiograph and illustrating the action of curare—in 1917—was to be given a pre-view of the influence of applied physiology on the clinical practice of the nineteen-thirties and forties".

Outside academic life, Barry had other interests. He played chess and bridge—some golf also, but found it too time-wasting for him; so he kept himself fit even in his advancing years by a vigorous, daily half-hour game of squash.

Since retirement, Barry had lived in London, where he died on April 15. He is survived by his widow (who still resides in London) and two sons, both in the medical profession: Claude (called after Claude Barnard, who deeply influenced Barry) in Edinburgh, and René in London. Barry's only daughter died in childhood.

Barry will long be remembered in Cork, where the Physiology Department is a monument to his ability and unselfish work for research. Many of his students now have distinguished positions, and all can look back on him as a very fine teacher and a valued friend.

Joseph Reilly

Prof. Gwyn Williams

Prof. Gwyn Williams, professor of chemistry in the University of London (Royal Holloway College), died suddenly in hospital on April 6, at the age of fifty and at the height of his scientific activity.

Born on November 27, 1904, he was the only son of the late J. W. Williams, of Cae Ffynnon, Llandudno Junction, North Wales. He was educated at University College School and later became a student under Prof. K. J. P. Orton at University College, Bangor. After graduation, he was at St. John's College, Cambridge, as a Strathcona research student for two years, returning to Bangor in 1929 as a Fellow of the University of Wales. For a further five years from 1931 he worked in Cambridge on independent research in the Departments of Colloid Science and of Physical Chemistry. Later he spent some months in the research laboratory of the Eastman Kodak Co. at Rochester, U.S.A.

It was not until 1939, at the age of thirty-four, that he took up academic teaching as assistant lecturer at King's College, London—then evacuated to Bristol. He was soon, however, given a more responsible position, and in 1946 he was appointed to the chair of chemistry at the Royal Holloway College, University of London. Since that time his department has thrived under his guidance and has become an active centre of research. He succeeded in obtaining a new building with greatly increased accommodation which was completed in 1951.

Dr. Williams's scientific work was concerned with the kinetics and mechanism of various chemical reactions, starting with studies of the chlorination of anilides under Orton and Soper and, at Cambridge, including the addition of bromine to olefins and the related problem of the catalysed polymerization of styrene, which he was still studying in recent years.

During the war years at Bristol, he joined with other members of the King's College staff in work on T.N.T. production for the Ministry of Supply, and this led to detailed kinetic studies of nitration in sulphuric acid. Williams took a prominent part in this work, which demonstrated the importance of the nitronium ion as the active agent in such nitrations. In recent years he had extended this study of nitrations very considerably, and had made use of Hammett's acidity function and of various triarylcarbinol indicators in interpreting the results. The reversible nitration of guanidine and the esterification of alcohols by nitric and sulphuric acids were also examined in detail.

Prof. Williams served his College as a member of its Council and its Finance Committee; he was for a long period secretary of the Board of Studies in Chemistry of the University of London and latterly a member of the Senate. He also took a keen interest in Coleg Harlech, of which he was honorary treasurer. He was a chess player and a member of the Alpine Club, having climbed a great deal in Wales and Switzerland. He was an unassuming man, an assiduous worker and a wise and staunch friend. It is a tragedy that his work should have been cut short so abruptly.

NEWS and VIEWS

Botany at Cardiff: Prof. R. C. McLean

Prof. R. C. McLean is retiring at the end of the present session from the chair of botany in the University College of South Wales and Monmouthshire (Cardiff). A pupil of F. W. Oliver at University College, London, he worked on fossil plants with Sir Albert Seward at the Cambridge Botany School, pioneered in the ecology of tropical rain forest while attached to the botanical gardens at Rio de Janeiro (then directed by J. C. Willis) and later taught for some years at University College, Reading. During the First World War he served as a medical bacteriologist. In 1919 he was appointed to the chair of botany in Cardiff, and the thirty-six years of his tenure of office at Cardiff have seen his Department increase greatly in size and importance. A subdepartment of bacteriology has been formed, a cinéphotographic production unit has been set up, a new physiological laboratory has been opened, and a botanic garden has been established on the outskirts of Cardiff; and but for the Second World War, the Department would have moved into the new building which has been designed under Prof. McLean's direction and will soon arise in Cathays Park. He is noted for his encyclopædic knowledge and wide sympathies, and for the lucidity of his exposition, and he has undoubtedly had a great influence on the teaching of botany not only in Wales but also far beyond. Prof. McLean's lifelong devotion to outdoor studies marked him out to be the one botanist to be appointed both to the Nature Conservancy and to the National Parks Commission when those two bodies were first set up. During the inter-war period Prof. McLean visited several countries in Europe in connexion with work of the International Association of University Professors and was president of the Association in 1953; he had previously (in 1940) been president of the Association of University Teachers. He has recently toured the world in order to visit national parks in overseas countries and to study their

administration. He hopes during his retirement to complete a monumental text-book, the first volume of which has already appeared, and to pursue further the study of botany in other lands.

Prof. G. F. Asprey

PROF. G. F. ASPREY, who is to succeed Prof. R. C. McLean, has been professor of botany in the University College of the West Indies since 1948. Prof. Asprey is forty-six years of age, and is a graduate of the University of Birmingham, where he specialized in the field of plant physiology. Afterwards he joined the staff of the University of Glasgow and held there a Carnegie fellowship during 1934–37, and was appointed lecturer in botany. During almost the whole of the War period he served with the Royal Electrical and Mechanical Engineers, in charge of the maintenance of radar equipment in the field. Latterly, he went to the Army Formation College at Stourport, where he was head of the biology section. After a short period back in Glasgow, he went in 1947 to the University of Aberdeen as lecturer in plant physiology, and from there the following year to Jamaica. In the West Indies he was faced with the task of planning and building up an entirely new department in which active teaching had to begin almost immediately. It is not hard to understand the difficulties involved in such a position; but the new professor was also called upon to serve as dean of the Science Faculty and as a member or chairman of numerous administrative committees and, for some months, as acting principal of the College. He leaves his Department well equipped and actively engaged in research in plant physiology, ecology and pathology. Prof. Asprey's primary interest has been in physiology; but he has added to this, in later years, ecological, taxonomic and economic studies on the West Indies vegetation particularly, and extensive work on the medicinal plants of Jamaica. He therefore takes to the University of Wales a breadth of experience and interests which should be of great benefit in his new surroundings.

Safety in Mines Research Establishment: Mr. H. T. Ramsay

MR. H. T. RAMSAY has been appointed director of the Safety in Mines Research Establishment of the Ministry of Fuel and Power. He succeeds Mr. A. H. A. Wynn, who resigned on his appointment to membership of the National Coal Board. Mr. Ramsay was born in 1907 and graduated from the University of London in 1932. For much of his career he served under Sir Clifford Patterson at the Research Laboratories of the General Electric Company, working on the application of discharges in gases to high-voltage rectification and related projects. In 1939 this work was found to have applications to radar, and his group worked on these problems throughout the War. In 1944 he was appointed to the leading staff of the laboratories and in 1948 he left the General Electric Company to join the Armaments Department of the Royal Aircraft Establishment, where he worked on problems of fighter armament. In 1949 Mr. Ramsay moved to guided missile development, where he led a group studying associated analytical and electromechanical problems. Early in 1953 he went to the headquarters of the Ministry of Supply to supervise a group of major industrial projects associated with this work. In 1954 he joined the Ministry of Fuel and Power and was appointed to the Safety in Mines Research Establishment.

Element 101: Mendelevium

AT a recent meeting of the American Physical Society, reported in *The Observer* of May 1 and *The Times* of May 2, an announcement was made of the preparation of yet another new element, namely, element 101. The credit for this latest achievement in nuclear science goes again to Prof. G. T. Seaborg and his collaborators at the University of California, Berkeley. Very few details about the new element are as yet available. It has been produced by bombardments of lighter elements in the cyclotron, and only a few atoms of it have been observed; nevertheless, the power of the methods used by the Berkeley team is such that identification can be regarded as certain. Although new names are still not forthcoming for elements 99 and 100, which were reported first more than a year ago, it is interesting to see that the name proposed for element 101 is 'mendelevium', presumably with symbol Me. This is a striking tribute to the Russian founder of the modern Periodic System of the elements, and implies that the chemical properties of the element agree, so far as they have been studied, with what is to be expected for an analogue of thulium. That the very heaviest elements should show rare-earth-like properties is now, of course, firmly established. One looks forward to the completion of this group of elements, at element 103; the investigation of element 104, if it ever becomes possible, will indeed constitute one of the most rigorous tests of modern conceptions of the electronic structure of the elements.

Maintenance Rates for State Scholars

DETAILS of the new maintenance rates for students at universities, announced by the Minister of Education, Sir David Eccles, in the House of Commons on April 26, have been published as Ministry Circular 285 and Administrative Memorandum No. 502 and sent to local education authorities. The arrangements are intended in the first place for State scholars and other holders of Ministry awards; but the Circular urges on all local education authorities the desirability that all students who attend a particular university with awards from public sources should receive grants at the same rates and on the same basis of assessment, and that accordingly the proposed arrangements should be adopted as soon as possible by all local education authorities. The new rates for board and lodging during term-time, which represent an increase of about 10 per cent and include an allowance for travelling expenses of £10–5, range from £283 to £225 for resident students and £171 (London) or £156 (elsewhere) for those living at home. The normal rate of vacation allowances will continue to be in the range £25–20; but the higher allowances for those in special need have been increased to £47 10*s*.–£38 10*s*.; the additional rate paid to students for an approved course of study away from home during vacation has also been increased to £3 10*s*. Students will now be allowed to retain prizes and awards of merit in the form of single payments up to £100 in any one year, and the annual honorarium paid to State scholars who do not qualify for assistance or hold any other award will be raised to £50.

In assessing parental contributions towards the cost of university education of State scholars, the deduction allowed from gross income for each wholly dependent child (other than the scholar) will be increased to £150, as will the maximum allowance for educational expenses and school fees and the maximum allowed for other dependants, while the

maximum allowance for university education or professional training will be raised to £300. The income scale against which the parental contribution is read off after the appropriate deductions against gross income have been made has been adjusted so as to decrease the contributions of parents with "scale" incomes of £900 a year upwards and bring into the range of assistance some parents whose sons or daughters at present only qualify for the honorarium. Special attention is directed to the arrangement now proposed for the benefit of families where more than one member holds an award. Under this the parental contribution expected is no greater than if there were only one scholar, and the Minister proposes to make arrangements with local education authorities for a similar provision where one or more members of the scholar's family hold local education authority awards. The new income scale and allowances come into force next October.

University of Reading

The Chancellor of the University of Reading, Viscount Templewood, on May 18 laid the foundation stone of the new Faculty of Letters building. This marks the beginning of a scheme which will ultimately result in the transfer of the whole University to Whiteknights Park, a parkland site of three hundred acres on the southern outskirts of the town. The architects are Messrs. Easton and Robertson, and the builders Messrs. Taylor Woodrow Construction, Ltd. It is hoped that the building will be fully occupied by October 1956.

Desert Locust Control Organization

The East Africa High Commission has appointed the following Commission to investigate the Desert Locust Control Organization: Sir Francis Mudie (*chairman*), Dr. B. P. Uvarov, director of the Anti-Locust Research Centre in London, and Mr. G. B. Crichton, a member of H.M. Treasury and head of one of the branches of the Organization and Methods Division; the secretary will be Mr. A. J. Fairclough, of the Colonial Office. The terms of reference of the Commission are: "To review the present operations of the Desert Locust Control Organization with particular reference to the desirability or necessity of the present level and geographical spread of expenditure on locust control work, and to make recommendations for the future; to review the arrangements for financial control and accounting methods of the Organization, and to make recommendations".

Science and Progress in Under-developed Areas

Another seminar on science in the tropics, entitled "Science and Colonial Development", was held in the Institute of Commonwealth Studies (University of London) from January to March. The seminar comprised thirty-one members under the chairmanship of Dr. W. F. Jepson (Imperial College of Science and Technology, London), who, with Prof. G. Macdonald (London School of Hygiene and Tropical Medicine) and Dr. J. R. Raeburn (London School of Economics), organized and led the proceedings. Sessions were also led by Mr. J. Rose (Colonial Office) on administration, Prof. B. S. Platt (London School of Hygiene and Tropical Medicine) on human nutrition, Dr. A. P. Stirling (London School of Economics), social anthropologist, on social aspects of development, and Dr. H. Greene (Rothamsted Experimental Station) on soil science. The seminar provoked lively discussion on the ends and means of the scientific worker and the administrator, some salient points being the retention of fundamental research largely in the cultural centres, and the strengthening of the life-line towards the scientist working in under-developed areas, who will seek every means to interpret scientific techniques to his colleagues in other fields, to administrators and, most of all, as a member of a team, to the peasant population. An Indian speaker referred to the possibilities of using troupes of actors to present scientific results in palatable dramatic form. This technique is familiar in Britain in army instruction by means of playlets. All were agreed on the desirability of making a wider use of district teams and of paying more heed to the results of anthropological studies before embarking on social and economic development. It is hoped to arrange a similar seminar during the academic year 1955–56.

Soviet Researches in the Arctic

The Canadian Defence Research Board has made available a translation of a brief report of the Soviet Arctic Research Institute, under the title "New Soviet Researches, Explorations and Discoveries in the Central Arctic" (translated from *Izv. Akad. Nauk., Ser. Geog.*, **5**, 3–16 (1954), by E. R. Hope (Ottawa: Defence Scientific Information Service, Defence Research Board, 1954)). The report is a broad review of the achievements of recent Soviet studies in the Arctic. This includes the discovery of a great underwater mountain range dividing the arctic basin; also new information concerning the ice cover and its drift motions. There is a qualitative description of the meteorological conditions and heat balance and, lastly, a description of the geomagnetic results including the pattern of diurnal variation of the field that occurs at high geomagnetic latitudes. The organization and logistics of Soviet arctic exploration are also briefly mentioned. The report will be of interest to geographers, oceanographers, geologists, meteorologists and geomagneticians. It presents only the major conclusions reached in the various fields of study concerning this vast region. Many would no doubt like to have access to the detailed data as well.

The University Education Department

Following his appointment as professor of education in the University of Sheffield, Prof. W. H. G. Armytage delivered an inaugural lecture on the role of an education department in a modern university. After describing the evolution of the education department, Armytage suggests that its present role is "to afford a little breathing space of one year to all intending teachers, in which we try and help them put together something that has, in many cases, been progressively taken apart and broken down into its constituent elements. We hope in this year that students can learn something about their knowledge, and, in doing so, become the kind of teacher needed in the twentieth century". Copies of this interesting and wide-ranging lecture can be obtained from the Registrar, University, Sheffield 10.

Investigations of Flower Colour

In biochemical and genetical investigations of flower colour, and using the method of paper chromatography, Tōru Endō (*Jap. J. Bot.*, **14**, 2, 187; 1954) has carried out an analytical study of the inter-relationships of various pigments in their constituents underlying the flower colour in *Viola*

tricolor. The definitive identification of the individual pigments is deferred. Some ten varieties of the Swiss giant pansy were used, their propagation being by sib-mating. It was ascertained that two flavones, five anthocyanins and five carotenoids were involved in producing the characteristic floral colorations in these varieties. These pigment constituents, in varying proportions and intensities, determine the phenomena of flower colour. The author concludes that pigments of the same kind tend to occur in groups, and this has enabled him to offer an interpretation of the mutual relationships among the varieties investigated.

Engineering Research in India

THE Board of Engineering Research, recently set up by the Council of Scientific and Industrial Research, India, has as a first step caused a survey to be made of the engineering research in progress in India and of the facilities that exist; this survey has been published by the Council under the title "Engineering Research in India", by V. Cadambe (pp. 144; New Delhi, 1954). The compiler has cast his net widely, and his review covers activities ranging from aviation to architecture that are to be found in government institutions, educational establishments and industry. Standards of skill and knowledge are known to differ widely; but only in the section on applied mechanics is the reader helped by a list of published papers to arrive at a definite understanding of what has been actually accomplished during the past few years. Recommendations covering the entire field are put forward in detail.

Society for the Bibliography of Natural History

THE annual general meeting of the Society for the Bibliography of Natural History was held at the British Museum (Natural History), London, S.W.7, on April 27. Mr. C. Kirke Swann addressed the meeting on natural history books from a bookseller's point of view. The second part of the third volume of the Society's *Journal* was issued in March 1955, containing eight articles, of which one is a select list of bibliographical reference works in zoology. The following have been elected as officers: *President*, J. Ramsbottom; *Honorary Secretary and Treasurer*, A. C. Townsend (British Museum (Natural History), London, S.W.7); *Committee*, A. G. Davis, W. N. Edwards, F. C. Fraser, F. J. Griffin, W. T. Stearn and C. Kirke Swann.

Brazilian Society for the Progress of Science: Annual Meeting

THE sixth annual meeting of the Brazilian Society for the Progress of Science (Sociedade Brasileira para o Progrêsso da Ciência) was held during November 8–13 at the Faculty of Medicine in Ribeirão Preto, a rapidly growing coffee centre in the interior of the State of São Paulo. The decision to hold the meeting there reflects a deliberate policy aimed at the 'cultural penetration' of the interior of Brazil. The president for the year was Prof. Lauro Travassos, a well-known Brazilian zoologist, and four hundred and twenty scientific workers and others enrolled for the meeting. A hundred and one papers were read at the fifteen sessions, and the great majority of these were devoted to biological subjects. In addition, there were symposia on science and food production, chromatography, venomous animals, and the chemotherapy of tuberculosis; a colloquium on experimental and theoretical physics; and popular lectures and film-shows. Lectures given at the inaugural and closing sessions centred mainly around the problem of financial aid for science, and the Governor of São Paulo State spoke in support of the proposal that ½ per cent of the income of the State should be devoted to scientific research; this would provide about £600,000 a year for research in the State of São Paulo. A number of scientific workers from abroad attended the sessions, including Prof. Robert Stämpfli (University of the Saar) and a representative of the British Council; local newspapers took the opportunity of giving publicity to the meeting in Oxford of the British Association. The next meeting of the Society will be held at Recife during June/July.

Announcements

CAPTAIN KENNETH ST. BARBE COLLINS has been appointed hydrographer of the Navy in succession to Vice-Admiral Sir Archibald Day, who has held this appointment for five years.

PROF. JAMES KENDALL will deliver the Leonard Dobbin Memorial Lecture on "Michael Faraday" on June 6 at 4.30 p.m.; this will be the first Alembic Club Lecture to be delivered under the auspices of the Royal Society of Edinburgh.

DR. N. H. CHAMBERLAIN, senior lecturer in rayon technology in the Department of Textile Industries, University of Leeds, has been awarded the Warner Memorial Medal of the Textile Institute in recognition of outstanding work in textile science and technology, and particularly for work published in the *Journal of the Textile Institute*.

THE second congress of the International Diabetes Federation will be held in Cambridge during July 4–8. The congress will cover the problems of laymen, medical practitioners and scientific workers; thus some sessions will discuss social problems (national and international) where the emphasis will be more on the medical side, some will be for laymen only, covering social problems of a purely welfare nature, and others will deal with clinical and scientific matters. The languages of the congress will be English and French. Further information can be obtained from the organizing secretary of the congress at 152 Harley Street, London, W.1.

THE Summer Meeting of the Physical Society will be held in the Lecture Theatre of the George Holt Physics Laboratory, University of Liverpool, during July 5–6, the subject of the meeting being "High-Energy Nuclear Physics". Contributions are expected from the Atomic Energy Research Establishment, Harwell; University of Birmingham; University of Glasgow; University of Liverpool; University College, London; University of Oxford; and University of Rochester, New York. Accommodation can be arranged in Derby Hall Hostel, North Mossley Hill Road, Liverpool 18, if application forms are sent there before June 16. The meeting is open to all on application to the Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7.

IN the account of the activities of the Commonwealth Fund, New York, published in *Nature* of April 23, p. 716, two mistakes have occurred in the last paragraph. The appropriations should read: 100,000 dollars for advanced fellowships in medicine and allied fields, and 685,890 dollars for the two-year budget of the Division of Education, the name of which has recently been changed to Division of International Fellowships.

SOILLESS CULTIVATION OF CROPS IN INDIA

By J. W. E. H. SHOLTO DOUGLAS
Officer-in-Charge, Hydroponic Research, Ministry of Food, India

WITH the object of evolving less-complicated methods of soilless cultivation, research studies in hydroponics were commenced in 1946 at the Government of Bengal's experimental station at Kalimpong in the Darjeeling district of India. The object was to perfect a novel system of which practicability and simplicity would be the keynotes, suitable for use by the layman. It was hoped that eventually hydroponics would be able to make the large cities self-supporting in all vegetables, and bring barren regions under cultivation.

The results achieved, after a period of nine years experimental work and extension activity, are of some interest. Not only in India, but also in other countries, the Bengal methods of soilless culture have made good progress. Inexpensive to instal, simple to maintain and economical to operate, the technique has reduced equipment to a minimum, and made full use of indigenous materials, while straightforward rules have been framed to guide the operator.

Hydroponic troughs have been laid down at the most unpromising sites. With the Bengal system, beds may be made from almost anything except galvanized iron, but if this has to be used it should first be given a coating of asphalt enamel. Wood, concrete, felting, bricks, mud plaster, iron and steel, asbestos sheets, and puddled alkali-treated clay are all satisfactory. The best width for troughs is one yard, and any convenient length. The sides of a hydroponic bed should be about eight inches in height. Drainage is provided by semi-porous walls and small holes around the bases, with guttering to carry off seepage. The bed is filled to a depth of eight inches with a coarse inert aggregate, preferably a mixture of five parts of stone chips, gravel, broken bricks, or leached cinders, of $\frac{5}{8}$-$\frac{1}{4}$ in. grade, and two parts of sand or rock dust. This is the growing medium. Water is introduced to this aggregate by a system of inlet pipes. An ideal degree of saturation has to be maintained: the best example is to say it should resemble a damp sponge just lightly wrung out. Excessive dryness or water-logging has to be avoided.

The nutrients may be applied in more than one way. A balanced formula made up of fertilizer grade salts, and applied dry by spreading between the rows of growing crops, at the rate of two ounces per one square yard of trough surface space every ten days, is the most popular method. Nutrients applied dry must be immediately watered in with a light spray of water. Resort may also be had to amberlites, or synthetic resins on which are adsorbed cations and anions. These will supply the plants with the necessary nutrients throughout the whole growing season only one application being called for.

In India, the following formula, made up from fertilizer-grade salts, has given good results:

Fertilizer	
Nitrate of soda	14 oz.
or	
Ammonium sulphate	12 ,,
Superphosphate	6½ ,,
Calcium sulphate	3 ,,
Potassium sulphate	5 ,,
Magnesium sulphate	4 ,,
Trace elements	¼ dram

The minor elements mixture consists of:

Zinc sulphate	3·0 dram
Manganese chloride	9·0 ,,
Boric acid powder	7·0 ,,
Copper sulphate	3·0 ,,
Iron sulphate	10·0 ,,
	32·0 dram

Application rate for this nutrient mixture is 1½–2 oz. per square yard of trough surface space every week or ten days, as required.

The quantities of synthetic resins used per one square yard of trough space to last for six months are as follows:

Amberlite	
Ca^{++}	37 oz.
Mg^{++}	18 ,,
$H_2PO_4^-$	2½ ,,
$SO_4^=$	5 ,,
$H_2BO_3^-$	1 ,,
Fe^{++}	1 dram
Mn^{++}	½ ,,

Potassium nitrate is applied two or three times weekly in the irrigation water at the rate of 20 oz. to 100 gallons of water. Other elements are present as impurities in the media.

Glass matrices, of the following composition (per cent), are now being tested with the object of substituting them for the trace-element mixture hitherto used in the fertilizer grade salt formulæ: boron, 2·5; manganese, 4·4; iron, 11·0; molybdenum, 0·22; copper, 0·44; and zinc, 4·4. Rate of application is 1 lb. to 400 square feet of surface area per season.

The general aim has been to maintain a balance of the nutrient elements within the following framework, whatever the vehicle used for supplying them may be:

Element	p.p.m.
Nitrogen	200–400
Potassium	100–200
Phosphorus	80–100
Magnesium	50–100
Calcium	300–500
Iron	2–10
Manganese	0·5–5
Boron	0·5–5
Copper	0·5
Zinc	1·0

A deficiency of any particular element has been found to produce symptoms approximating to those listed below:

Characteristic symptoms	Indicating a lack of
Plant light green in colour, slow growth, general necrosis of tissue, poor development, stunted and yellowish leaves	Nitrogen
Abnormally dark green plants, purple or reddish pigmentation, dull appearance	Phosphorus
Crinkled and curled leaves, mottling in places with chlorosis at tips, brown and scorched foliage	Potassium
Dark, stunted appearance, death and blackening of terminal buds, shortened roots with necrotic apices	Calcium
Chlorosis between leaf veins, spotting first white, later turning to brown	Magnesium
Severe intervenal chlorosis, followed by burning, veins remain green	Iron
Small brown necrotic spotting or checkering following chlorosis	Manganese
Veins turning yellow with dead areas of a purple colour forming at leaf bases. Entire plant yellowish	Sulphur
Distortion of leaves, chlorosis beginning at bases and margins, gummy or corky deposits in fleshy organs, hollowing, brittle stems	Boron
Irregular chlorotic spotting between veins of older leaves, necrosis rapid with defoliation. Die-back stunting	Zinc
Pronounced top wilting and lack of turgor, some chlorosis	Copper

*p*H values of the moisture present in hydroponic beds operated under the Bengal system should approximate to readings between 6·0 and 6·5. These are the most suitable reactions for all general crops, though experience has indicated that for some plants, such as potatoes, a lower *p*H, such as 5·0, is desirable. However, for practical work it is necessary to lay down a figure which gives reasonable results in most circumstances. BDH Universal is a satisfactory indicator for use by the relatively unskilled person. A variation of a few grams in the salts applied in bulk under practical conditions is immaterial. In India, care is always taken to impress upon growers that the rules laid down for operating techniques must be strictly followed, since the safety margin is narrow. Very often tablets containing the complete formula, or packeted ready-mixed salts, are issued to the public.

In Bengal, at the experimental sectors at Kalimpong, the salinity of the water supply is between 120 and 130 parts per million.

Overhead shading of mats is provided on canopies eight feet high, so as to admit morning and evening light, but to exclude the scorching rays of the noonday sun. Evaporation is also checked by these devices. In colder climates, such as that of the United Kingdom, cloches could easily be fitted to provide protection in winter.

Results. A few of the trials undertaken in Bengal are reproduced to illustrate what has been achieved :

Tomatoes : Plots of Suttons 'Best of All' have given averages of 22 lb. of fruit per plant, excluding 'chats', as against soil control yields of 8–10 lb. Acreage averages come to 150 tons. Growth period is about 170 days, with picking beginning on the ninetieth day after sowing.
Lettuce : Several varieties, including 'New York', 'Cos', 'Wayahead', gave crops of between 30 and 50 lb. per 100 square feet, with a growing time of 35 days.
Maize : 'Yellow Flat' maize has produced yields of 6,000 lb. of grain per acre, against the usual crop in soil of 2,000 lb.
French Beans : Dwarf 'Canadian Wonder' produced 1 lb. per square foot of edible pods 40 days from sowing. Picking continued for a month.
Rice : 8,000 lb. of grain per acre.
Potatoes : Averages of early new varieties ('Darjeeling Red') gave a tonnage of 55 to the acre, and maincrops 90 tons.
Onion : Variety 'Baluchistan', yield amounted to 160 lb. from each 200 square feet of bed.
Beetroot : ¼ lb. to the square foot in soilless beds.
Broad Bean : A yield of ¼ lb. to the square foot.

The question of water consumption has also received attention. It is of considerable importance. Obviously hard and fast rules cannot be laid down, since in different regions the rate will vary. In North Bengal it needs 200 gallons two or three times a week during the dry season, with maximum and minimum daily temperatures of 80° F. and 50° F., to keep suitably moist a trough of one thousand square feet. Less is required in colder places, and more in very hot localities, unless the climate is humid. However, hydroponics under the Bengal system compares favourably with soil, since it is obviously better to run the available water supply into controlled soilless beds than to dissipate it wastefully over the fields. At no time should 'ground' temperature, that is, surface heat of the soilless beds, be allowed to exceed 90° F., otherwise transpiration will pass the safety limit. This problem has been solved in Bengal by using the overhead canopies.

A device for automatically distilling fresh water from brine for use in hydroponics has been tested successfully. In India, the apparatus, which consists of a dome of metal covering water trays surrounding a central column of calcium chloride, has given good results. It works by means of the sun's heat, evaporating the trapped water into vapour in the day-time, which then condenses at night with the fall in temperature. The salt is left in the trays. The device is portable.

Further trials are proceeding at the Indian units with additional aids to cultivation, such as phosphate pebble rock, and crushed rock phosphates, activated sludge powders, wood ashes, effluents, and other materials.

A Hydroponic Information Centre has been opened at P.O. Box 31, Bombay, India, to provide advice and literature on the method.

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ELECTRONICS IN THE IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, LONDON

By Dr. D. GABOR

IN recent years, the shortage of physicists and engineers trained for the development and production of valves and electronic devices of all kinds has become alarming. The British valve industry is at present producing valves at the rate of 60 million a year, and television tubes at the rate of 1·8 million. Not only future expansion but even the maintenance of the present volume of production will be jeopardized unless research, development and modern production methods keep step with international competition, and this depends in the first place on the supply of trained specialists. Recognizing this situation, two years ago the British Radio Valve Manufacturers Association approached Prof. Willis Jackson, then head of the Electrical Engineering Department in the Imperial College of Science and Technology, London, with an offer of support for a full-session postgraduate course in applied electron physics. With the aid of a generous special grant by the University Grants Committee, the Electronics Laboratory of the College was completely re-equipped, and the course opened for the session 1953–54. It now forms a permanent part of the general postgraduate course in electronics and communications which was first organized in the College in 1949.

The curriculum is intended to follow, more or less, the course of a vacuum device from research through development to production. All electronic vacuum devices are based on the dynamics of the free electron in electromagnetic fields ; hence the course starts with an introduction to electron dynamics and a recapitulation of electromagnetism, immediately followed by practical exercises. The students receive their first introduction to high-vacuum techniques at a special test-bench, fitted with all types of vacuum gauges, where they can verify for themselves the laws of the flow of gases at low pressure, pumping speeds, etc. Another test bench is equipped for the verification of the basic laws of gas discharges, and a third, a large demountable vacuum tank, for the demonstration of electron optics.

As rigorous analytical methods are seldom applicable to practical problems, the main emphasis in

the teaching of electron dynamics and electromagnetism is on numerical and model methods. A large electrolytic tank is available for the rapid and accurate charting of electrostatic fields in two or three dimensions, and for certain magnetostatic fields. Electron trajectories are plotted graphically by a hand-operated tracing trolley and by other methods. In the special case of cylindrical or 'plane' electrostatic fields, a large rubber-membrane model enables the field and the electron trajectories to be obtained in one experiment, by rolling steel balls over the membrane. These methods are usually sufficient for an approximate design of the electrode shapes in valves, television tubes, electron multipliers, image tubes and other devices. For the testing and final correction of the design, demountable vacuum chambers are the most effective aids of the research and development engineer. Three large metal vacuum tanks are available, in which vacua of the order of 10^{-5} mm. mercury can be maintained while six or more mechanical adjustments are carried out from the outside without breaking the vacuum.

Once the electron-dynamical design is fixed, technological development can start, which leads ultimately to a sealed-off device, to be put in the hands of the circuit engineer. The technological equipment of the Electronics Laboratory in the Imperial College is sufficient for making up almost any type of vacuum device, and for instructing the students in most of the usual processes. The glass-blowing shop is equipped with a large horizontal glass lathe and two smaller vertical machines, with supplies of coal gas, oxygen and hydrogen for glass and quartz blowing, and with annealing ovens. Two hydrogen furnaces and a muffle oven are available for the heat treatment, in protective atmospheres, of metals for use in vacua, and a large, 30 kW. vacuum furnace is under construction for temperatures up to 3,000° K. A number of spot welders and a small atomic arc welder are provided for the assembly. The exhausting of valves up to the size of small cathode-ray tubes is done on two medium-size exhaust stands; a large stand serves for television tubes; all are supplied with high-frequency power from a large induction heater. An electroplating and cleaning plant and several stands for vacuum coating of metals complete the technological equipment.

The theoretical training of the postgraduates centres on vacuum electronics; but in view of the growing importance of semiconductor valves, they attend also a course on the physics of solids. (Laboratory equipment for germanium techniques is available.) Other items in the syllabus include electromagnetic theory, microwave techniques and circuit theory, with exercises in the Microwave and Communications Laboratories of the Department. There is ample opportunity for attending special courses on mathematics, wave mechanics, higher circuit theory, acoustics, ultrasonics and communication theory for those specially interested.

From its inception in 1953, the lectures given in the course by the teaching staff of the Imperial College have been supplemented by special lecturers from industry. Leading specialists have been invited to give comprehensive surveys of technological topics such as ceramics, metals *in vacuo* and glass, and on advanced electronic topics such as microwave valves; also on engineering economics and quality control, which are of special interest for future production engineers.

The postgraduate course of the College in applied electron physics is open to applicants holding the B.Sc. or higher degrees of British, Commonwealth or equivalent universities, but in special cases also to holders of Higher National Certificates, if the applicants have had previous experience in electronic research, development or production, and if in an interview they are judged likely to profit from the course.

In the third term the postgraduates are given problems, usually of a practical kind, which might lead to useful results and which require independent thinking, and they are provided with experimental equipment for two to three months research or development work. Those who are successful are entitled to submit a thesis for the diploma of the Imperial College (D.I.C.). This is a unique opportunity for those who for some reason have missed the university, and whose gifts have been discovered too late, to obtain an alternative award with a recognized reputation.

The British Radio Valve Manufacturers Association is aiding this course not only by financing its running expenditures, but also by sending to it some of its engineers and physicists who, in its opinion, can profit more by broad and intensive academic instruction than by the experience which they could acquire in the same interval of time in an industrial laboratory or production department. Moreover, certain companies may be willing to subsidize the training of students who have the intention of joining industry after their postgraduate year, provided they show sufficient promise. Though the present shortage of electronic physicists and engineers makes it very desirable that entry into industry should not be much delayed, those attending this course who have shown outstanding scientific ability and interest are encouraged to do a further year or two in the Research School of the Electronics Laboratory. This will enable them to acquire the M.Sc. or Ph.D., provided they have the necessary first degree. Fully trained, hard-working specialists are indispensable for maintaining the present strong position of the British electronic industry; but only exceptional engineers and physicists can put it in the lead.

X-RAY ANALYSIS GROUP OF THE INSTITUTE OF PHYSICS

SPRING CONFERENCE

THE spring conference of the X-Ray Analysis Group of the Institute of Physics was held in the H. H. Wills Laboratory of the University of Bristol during March 30–April 1. The communications which were read by members of the Group and others covered a wide range of interests and were not restricted to any one particular aspect of X-ray crystallography. A particularly stimulating evening discourse was delivered by Prof. H. C. Longuet-Higgins, who discussed the peculiar problems posed by the structures of the hydrides of boron.

The first paper, by Prof. A. J. C. Wilson, dealt with his further investigations on the effects of various symmetry elements on intensity distribution functions. He has extended earlier studies to cover cases where molecules possessing centres of symmetry are placed in space groups containing other symmetry

elements in addition to centres of symmetry. The resulting distributions have been evaluated approximately: they are found to lie somewhere between the centric distribution (asymmetric molecules in a space group containing only a centre of symmetry) and the bicentric distribution (that is, molecules containing a symmetry centre in a space group with only a centre of symmetry). Expressions for the variance of the new distributions were given. Dr. T. H. Goodwin then described some results of applying the molecular orbital technique of wave mechanics to the calculation of bond-lengths in conjugated compounds. In the cases of a number of hydrocarbons excellent agreement was obtained between calculated bond-lengths and those observed by X-ray methods. Dr. W. Cochran and Mr. M. M. Woolfson have extended their studies of direct structure determination by calculating expressions for the probability of the correctness of sign relations for additional space groups. Their results, which are in good agreement with observations, show that in most practically important cases of reasonably complex structures the probability of obtaining correct signs directly from the observed intensities is low; no routine solution of the phase problem is as yet possible. Dr. A. Klug described new methods for the determination of absolute intensities of X-ray reflexions. In essence, the mean intensity curve is equated to the sum of the coherent and incoherent scattering at large values of $\sin\theta/\lambda$; where the course of the intensity curve is not directly observable in this region, it can often be calculated from that portion of the radial distribution function due to nearest neighbours. In the subsequent discussion it was suggested that it might be simpler to obtain the necessary information directly from powder patterns rather than to calculate it from single crystal data.

The next group of papers dealt with structure determinations. Dr. D. F. Grant and Dr. D. Rogers presented their results on the structure of hydroxydihydroeremophilone, a dicyclic sesquiterpenoid, which confirm the configuration proposed by Simonsen. This conforms to current theories of the biogenetic origin of the terpenes. The structure determination was presented as an example of the use of direct methods. The Sayre–Cochran relations proved to be of great value in the (100) projection in which the molecules are seen edgewise and in which there is much overlap of peaks, but not in the (010) projection—the plane of the molecules—since with about seventeen resolved atomic peaks there was little statistical bias in favour of the true sign. Mr. H. P. Rooksby discussed the crystal growth of barium and strontium oxides in oxide cathodes. Semi-micro beam methods were used, and the grain sizes were found to be of the order of a few microns. This technique revealed the presence at some stages of crystals several times larger than the mean size which had previously been estimated from line-broadening. In addition to crystal growth, the thermal treatment produces progressive lattice parameter changes not as yet fully explained. Considerable disturbances in the atomic arrangement are also indicated by the line-broadening which accompanies the crystal growth. Dr. J. C. Speakman had investigated the crystal structure of the acid salts of a number of monobasic organic acids. The majority of these salts, but not all, were shown to form symmetrical hydrogen bonds. Dr. H. D. Megaw and Miss C. H. Kelsey presented work on the unit cell of tobermorite, a hydrated calcium silicate. The structure is best described by reference to an orthorhombic unit cell; systematic absences indicate that the true lattice has a and b axes along the face diagonals of the orthorhombic cell, and is probably monoclinic A-face-centred. The crystal samples studied showed a variety of stacking faults and intergrowth phenomena. Dr. G. A. Jeffrey and Dr. G. S. Parry had re-examined the structure of aluminium nitride, which was shown to differ slightly from the ideal wurtzite structure with its tetrahedral arrangement of bonds, both as regards axial ratio and u parameter. Since, in determining the crystal structure it was only necessary to adjust the latter parameter and the temperature factors, it was found possible to use powder diffraction data. Dr. R. D. Lowde described a study of neutron diffuse reflexions produced by a Type I diamond selected for showing strong 'extra' X-ray reflexions. Similar neutron effects were found which showed that the structure fault characteristic of Type I diamonds is one which affects the atomic positions and is not an exclusively electronic phenomenon. The shape of the reciprocal lattice spikes as here determined by neutron diffraction and as studied by Wooster and Hoerni by X-ray methods lends weight to a suggestion that in Type I diamonds some parts of the structure have gone some way towards graphite, so that quite large changes of atomic positions are taking place. Small changes are ruled out by the X-ray results.

The most ambitious structure determination to be reported, and, indeed, perhaps the most complicated ever carried out, was that of a nucleotide-free degradation product of vitamin B_{12} by Miss J. Pickworth and Dr. D. Hodgkin. A three-dimensional Fourier synthesis based on the cobalt atom phases was first calculated. It indicated, together with information from similar calculations on the vitamin itself, the positions of some twenty-five atoms surrounding the cobalt atom in a porphyrin-like structure. From further Fourier syntheses, side-chains, mainly succinyl and acetyl attached to the inner porphyrin-like group, were identified and finally the positions of sixty-two atoms were calculated. The molecule contains about seventy atoms, other than hydrogen, its approximate formula being $CoN_8C_{47}H_{67}O_{15}Cl$, and although all the positions are not yet certain, the general nature of the molecule is now evident.

The remainder of the conference was devoted to apparatus and techniques. Dr. B. T. M. Willis described the use of gratings representing structures with stacking faults and of modulations of lattice parameter and scattering factor in a Lipson diffraction spectroscope. The gratings are prepared by moving a fine-grain photographic plate past a point image by means of micrometer movements: they contain at least 100×100 'atoms' and can be prepared in about one hour. Mr. E. F. Priestley showed how rapid fluorescence analysis can be carried out using photographic recording and curved lithium fluoride crystals as analysers. In order to detect fractions present to the extent of one part in ten thousand, exposure times of about half an hour are required: normally exposures of about one minute suffice. All elements heavier than potassium can be detected. In another paper he described the methods used for perfecting the monochromator technique and its application in conjunction with focusing powder diffraction cameras. Dr. W. C. Nixon gave an account of his point-source X-ray tube. Using magnetic

focusing, it has been found possible to produce a source less than one micron square on an air-cooled foil transmission target which can be loaded to a power of one watt. Thus the brightness is about 1,000 kW./mm.², as compared with an effective brightness of about 1 kW./mm.² in a normal foreshortened diffraction X-ray tube focus. The new point source has been employed principally in shadow microscopy, when a resolution of about 1000 A. has been obtained; applications in microbeam diffraction are being studied. Dr. J. W. Jeffrey analysed modern practice in intensity estimation where insufficient attention is often paid to experimental accuracy. He described methods of grinding specimens to a spherical shape to facilitate absorption corrections; the use of some form of integrating mechanism on moving-film cameras permits the employment of a very simple densitometer. Dr. U. W. Arndt reported only moderate success in the use of radioiodine for silver estimation in photographic images; the method gives a measure of the integrated intensities of single crystal spots. In spite of a number of ingenious suggestions to obviate this, it is generally necessary to punch out each spot individually before measuring the activity. The use of emulsions considerably thicker than normal increases the sensitivity to X-rays and the reproducibility of measured intensities at the expense of much more elaborate processing requirements. Dr. R. L. Gordon discussed methods of making 'lost counts' corrections in monitored Geiger–Müller counter systems and described a direct way of measuring the form factor for a self-rectifying X-ray tube. Dr. G. S. Parry and Dr. S. C. Abrahams gave brief descriptions of the General Electric and Norelco counter diffractometers, respectively.

Dr. R. W. Cahn had used the Buerger precession camera for metallurgical problems where the orientations of very small regions had to be verified, such as in the examination of mechanical twins in molybdenum. The very low background scattering allows very weak reflexions to stand out. Mr. H. J. Goldschmidt commented on some of the problems in high-temperature powder photography: his new camera, which was sponsored by the X-Ray Analysis Group of the Institute of Physics, provides the most satisfactory solutions to date. The greatest difficulties are those of specimen mounting and of evaporation of furnace windings; periodic calibration of thermocouples is always necessary owing to vapour contamination. Dr. R. Witty reported on his studies of X-ray tube characteristics. He pointed out the advantages of D.C. operation which, for the type of stationary anode design common in demountable X-ray tubes, permits a doubling of the target loading as compared with self-rectifying operation. Similar gains are possible with rotating anodes. He gave focal spot and saturation current characteristics as a function of bias voltage. This bias is most conveniently provided from a separate bias supply as distinct from a bias resistance. Mr. P. Holroyd and Dr. D. L. Smare had studied similar phenomena in micro-focus tubes. For fixed bias resistance the anode current rises exponentially, and the focal spot diameter falls exponentially, with decrease in anode – cathode separation. Dr. A. L. MacKay described a miniature Weissenberg camera and a miniature retigraph designed to take full advantage of the properties of a micro-focus X-ray tube in the examination of very small crystals. A number of novel features are incorporated, particularly in the design of the goniometer heads.

U. W. Arndt

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES

ANNUAL CONGRESS

The South-Eastern Union of Scientific Societies held its sixtieth annual congress in Folkestone during April 14–17, under the presidency of Dr. Russell J. Reynolds. Throughout the congress an exhibition of geological, archæological, botanical, zoological and general interest was on display at the Leas Cliff Hall, and the programme included a young naturalists' evening, when questions from children were answered by a panel of experts, and a lecture by Maxwell Knight on the habits of the cuckoo, illustrated by a film.

Dr. Russell Reynolds's presidential address to the Union was on "Cineradiography". He commenced by outlining the technique and application of his subject. Röntgen made his discovery in November 1895, and Dr. Reynolds still has a plate taken by himself by X-ray photography in 1896. Two years afterwards John Macintyre produced an X-ray cinematograph film by re-photographing on an ordinary cinematograph film a series of radiographs of a frog's leg which had been slightly moved between the exposures. Gradually the apparatus improved, tubes were more reliable and fluorescent screens gave greater luminosity. Sensitivity of film emulsion increased, and lenses of wide aperture were made. Two methods of making cineradiograph films became possible—the direct and indirect. The first utilizes the power X-rays have of affecting a sensitized photographic emulsion; in the second the rays passing through the subject strike a fluorescent screen, and the shadow cast is photographed. X-rays cannot be focused, and this limits the direct method. Difficulties with the indirect method include the weakness of the intensity of light emitted by the fluorescent screen; when this is increased, the exposure risk to the subject is also increased. Dr. Reynolds said that he began his cineradiographic experiments in 1921 using the indirect method. Later he introduced a switch which synchronized the excitation of the tube with the opening of the camera shutter, thus reducing both the exposure of the patient to risk and the strain on the tube by half. Improvements continued, and at the present time the method used is reliable and safe. The cost has been reduced and does not exceed that of a complete X-ray examination in the usual way. Modern apparatus has a specially designed transformer unit, and the X-ray tube has a double-focus cathode. The camera lenses have a wide field, the apertures being $f/0{\cdot}7$ and $f/1{\cdot}5$; the speed of the camera can be adjusted at will from 3 to 100 frames per second. The technique in making cineradiographic film differs little from that employed in normal radiography. Dr. Reynolds stressed the importance of the use of short coils of film that can be projected continuously, not only for the purpose of medical diagnosis, but also for training students.

The presidential address to the Archæological Section was given by Major H. M. Rand, who spoke on "The Saxon Shore Forts of Kent". He said that historical evidence, often not contemporaneous, can be misleading and that muddy boots are sometimes better than documents. The archæological approach is the correct one, and excavation may solve the problem of the 'lost centuries'. There is an absence

of uniformity in the forts: some are rectangular (Reculver), others oval (Pevensey), and the areas vary from five to nine acres. Occupation in some commenced in the first century and continued until the fifth; in others there is evidence of two separate periods in the second and fourth centuries. The coastline differs considerably from that of the present day, erosion and silting up, particularly of the Wansunt Channel, making the location of the forts problematical. The Kent Archæological Society commenced excavation at Richborough in 1922, and the fifth report is now in the press. The cruciform platform is unique, and may have supported a monument to commemorate a triumph during the third century; triple defensive ditches were raised about the same time.

Dr. Maurice Burton gave the presidential address to the Zoological Section, his subject being "Art in Animals". He said that he differs from some of his colleagues in the line drawn between man and the other animals, for we may tend to trust our reason too much. There is opportunity for us all to study the difference between human and animal behaviour. The love behaviour is much the same, that of male and female sticklebacks being a case in point. Maybe, he said, the difference is one of quantity rather than of quality. Dr. Burton spoke of the beauty, to our eyes, of the shells of single-cell animals, the Foraminifera, and of the sponge called the Venus flower basket. He mentioned the ability of lower life forms to take material from outside their bodies to construct beautiful homes—the tube-making worms, caddis fly larvæ and the nests of fishes and birds; the web of a spider compares favourably with the efforts of a civil engineer. The difference between man and the animals is that æsthetic appreciation has evolved man's consciousness of his art. In animals mechanical skill is highly developed. Dr. Burton then dealt with the evolution of the eye from the light-sensitive cell of the lowest organisms. The bower birds have especial skill in the construction of their elaborate houses, for they use natural pigments for colouring sticks, selecting favoured ones and burying those considered distasteful. Colour should be related to the development of the eye, and while at times its value is protective, at others it has a physiological value: it has signal values with the birds and fishes and arouses emotions. The appreciation of sounds by animals when they have no other apparent value than æsthetic was briefly mentioned by Dr. Burton, and also the question of taste.

Dr. Francis Rose, as president of the Botanical Section, spoke on "The Flora of Kent", saying that the earliest plant records are those of Turner, in 1549, dealing largely with the plants of the Dover area; the inaccessibility of the Weald prevented recording from there. The Elizabethan records were from the point of view of the herbalist; Gerard, in 1597, recorded plants still thriving in the same localities. Even during the nineteenth century transport was difficult in the Weald, thus accounting for some of the missing species in the work of Hanbury and Marshall. Dr. Rose commenced his work upon "The Flora of Kent" in 1942, and it will be published during the autumn of this year. Its sections deal with the distribution of species, the ecology, plant distribution as a whole and floral statistics. C. W. Wright chose for the presidential address to the Geological Section the subject of "Unsolved Problems in Cretaceous Stratigraphy and Palæontology" and commenced by saying that Folkestone can be regarded as the centre of English geology. Much work is left to be done in spite of the intensive work of Rowe, Jukes-Browne, Whitaker and the Weald Research Committee of the Geologists' Association. There are many surprises around the corner, said Mr. Wright. The beds at the base of the Albian, thought to be allied to the Lower Greensand, may be more closely related to the Gault. Although each ammonite carries its evolutionary life-history, species evolved and disappeared in such relatively short times that the gaps between the species now found causes problems which may never be solved owing to the vast amount of material denuded, so removing the required evidence. Lithographical similarity in various districts can be misleading as regards zoning, as palæontological evidence has proved a sub-zone difference in some cases. World-wide correlation is exceedingly difficult owing to the lack of evidence, and Mr. Wright emphasized that ammonite material, however fragmentary, is needed to aid the solution of the problems.

During the congress favourable weather conditions enabled the full programme of excursions to be carried out. The archæologists visited Wye College and Church, ancient occupation sites on the Downs, Studfall Castle, the Roman fort of the Saxon shore and a fortified Manor House at Westhanger. The botanists and zoologists went to Westwell, Hothfield, Little Chart, Saltwood, Romney Warren, Dungeness Bird Observatory and the Folkestone Corporation greenhouses. The geologists made excursions to the Warren Defence Works, the Stour Valley near Ashford, Great Chart, Kennington, Wye and Brabourne.

The sixty-first annual congress of the Union will be held next year in Tunbridge Wells during May.

CARNEGIE UNITED KINGDOM TRUST

REPORT FOR 1954

THE forty-first annual report of the Carnegie United Kingdom Trust*, to which are appended the accounts for the year ended December 31, 1954, covers the fourth year of the present quinquennium and is concerned chiefly with the development and direction of existing schemes. Such good progress has been made with the programme for the development of local museum services that during the year the allocation of £40,000 for the five years was increased to £50,000, most of the fund being earmarked for direct grants to enable museums to improve their standards of display. In this field, the most important event of the year was the reopening of the Taunton Castle Museum after its complete re-organization. The Trust notes that the service of expert reports has continued to be of much value to the museums movement, but that a major difficulty in re-organization has been that the schemes involve the exercise of technical skill beyond the resources of the museums concerned. Grants for reorganizing displays were made during the year to the Banff Museum, Hove Museum of Art, Museum of Leathercraft, London, Torquay Natural History Society Museum, Truro Museum and the Worthing Museum and Art Gallery. During the year, five village hall

* Carnegie United Kingdom Trust. Forty-first Annual Report, 1954. Pp. viii+43. (Dunfermline: Carnegie United Kingdom Trust, 1955.)

schemes receiving grant-aid were completed, and work began on three other schemes. The Trust welcomes the indication in the Queen's Speech on November 30 that restrictions on village hall expenditure will be eased, and it is hoped that building will be started during the next twelve months on the seven remaining schemes.

During the year, 269 new cases were referred to the Family Discussion Bureau, which also stabilized its function as a training agency. The Family Welfare Association expected to publish in February 1955 a book entitled "Social Casework in Marital Problems: Studies in the Development of a Psycho-dynamic Approach". The Trust is also specially interested in a project of the Association which seeks to provide by research some knowledge of the nature of problem families and to suggest how to deal with them, and also to provide social workers concerned with family problems with practical hints on day-to-day procedure when immediate action is demanded. Eleven Family Service Units are now operating, and the Trust's grant is supporting the development of units, the collection and assessment of research data, and, mainly, the training of social workers in family service techniques, which is done basically by closely supervised field-work with attendance at special courses organized by universities and professional bodies.

Good progress has been made in defining the work which the National Association for Mental Health, formally inaugurated last July, should attempt in the north of England. The research council set up by the College of Teachers of the Blind, to which the Trust promised a grant of £100 a year for three years for research into the possibility of establishing standard attainment tests for children in blind schools when making selections for further education, has also started research on the design and testing of apparatus to throw light on how the blind detect obstacles and whether the art can be taught; and a grant of £400 has been made to the British Association of the Hard of Hearing for the installation of a recently developed public-address system. A new course in applied social studies at the London School of Economics and Political Science was inaugurated with twenty-five students in October.

RADIATION SENSITIVITY AND THE MITOTIC CYCLE IN *VICIA FABA*

By Dr. JOHN McLEISH
John Innes Horticultural Institution, Bayfordbury

THE sensitivity of living organisms to ionizing radiations can be assessed in terms of rapid morphological change, chromosome breakage and gene mutation. It is generally agreed that sensitivity varies not only between individuals but also between the tissues within individuals according to the genetic constitution and physiological activity of their cells. In the dividing cell, sensitivity, which is readily assessed by chromosome breakage, can be influenced by the number of chromosomes[1], their position and mobility in relation to one another[2] and to the phase through which the cell is passing at the time of irradiation[3–4]. It may also be modified by various physical[5] and chemical[6] agents.

Yet there have been very few demonstrations of the influencing of sensitivity by genes[7] or by any of the visible elements comprising the chromosomes themselves[8]. In the latter case, this has been difficult to show since between closely related varieties or within single tissues there are rarely any detectable chromosomal differences which would form the basis of a comparison of radiation effect.

This difficulty can now be overcome to some extent by giving a preliminary chemical treatment to induce localized chromosome breakage. Such a treatment produces, within a single tissue, a mixed population of cells with known differences the variable response of which to a single irradiation can be studied.

In these experiments, secondary lateral roots of *Vicia faba* seedlings growing in tap water were treated with a 0·1 m*M* aqueous solution of maleic hydrazide for five hours. Maleic hydrazide is known to induce breakage in, or close to, heterochromatic segments[9]; and with the dose employed 83 per cent of breaks occur in and around the large segment in the nucleolar arm of the *M* chromosome. Thus the majority of acentric fragments carry nucleolar organizers. These become randomly distributed between daughter cells at the completion of one mitosis. Then, by a mechanism which I have described elsewhere[10], a high proportion form viable micronuclei, which persist and reproduce in step with the main nuclei through consecutive mitoses. After 2–3 days, cells are present in the roots with 0–5 nucleolar organizers.

In *Vicia* roots the mean time for the mitotic cycle is of the order of 24 hr.[11,12]. Therefore, after the maleic hydrazide treatment, when some cells had completed two mitotic cycles, an X-ray dose of 100 r. was given. Roots were then fixed 4, 6, 10, 14 and 18 hr. later (Fig. 1). But all these fixations were made 72 hr. from the start of maleic hydrazide treatment and in all cases the last 1½ hr. were occupied in pre-treatment in 0·05 per cent colchicine to facilitate scoring. Roots receiving maleic hydrazide or X-ray treatment alone were also fixed as controls. Observations were made on Feulgen squash preparations, and the total breakage (chromosome breaks B'' + chromatid breaks B' + minute fragments mB'') scored in all classes of metaphase cell. The results for cells with various numbers of nucleolar organizers are summarized in Fig. 2.

Differences in breakage between the different cell types are immediately apparent. But as radiation breakage has been shown to be at random[13,14] and proportional to chromosome-length[1], breakage frequencies must be corrected to allow valid comparisons between different cell types to be made. Statistical tests can then be applied after making allowances for changes in total chromosome-length per cell resulting from the deficiencies and duplications induced by maleic hydrazide. The frequencies shown in Fig. 2 have been corrected in relation to the normal chromosome complement in this way.

Breakage in cells with 3, 4 and 5 nucleolar organizers is significantly lower than in cells with two

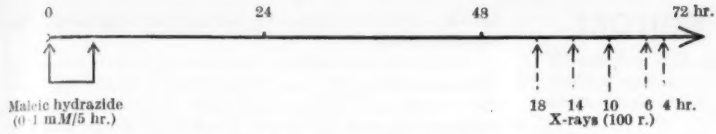

Fig. 1. Scale showing times at which roots were irradiated in relation to their earlier treatment with maleic hydrazide

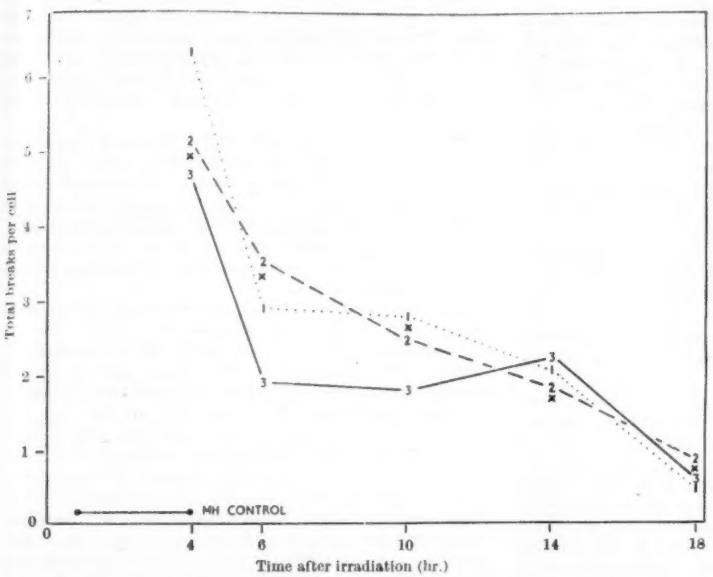

Fig. 2. Graph showing breakage frequencies in various cell classes at different times after 100 r. 1, cells with one nucleolar organizer; 2, with two organizers; 3, with three, four and five organizers (values lumped as they show no significant differences); ×, X-ray control. Cells without nucleolar organizers do not undergo mitosis. There is a low frequency of chemical breakage due to the maleic hydrazide treatment

organizers both at 10 hr. (7 d.f., $p < 0{\cdot}05$) and at 6 hr. (10 d.f., $p < 0{\cdot}001$). None of the other differences is significant. Apart from a possible exception at 4 hr., cells with one nucleolar organizer are less sensitive than might have been expected. This may be due to the proximity of cells with extra organizers, all having been derived from the same original cell.

What causes this decreased sensitivity in cells with extra nucleolar organizers at these particular times?

It is unlikely to be due to differences in mitotic-rates for the following reason. Cells show differences in the incidence of B' and B'' according to the time of irradiation in relation to the time of split. Thus the ratio B'/B'' for each cell class gives an indication of its relative speed of development and shows in these experiments that there are no significant differences between cells with different chromosome complements. However, there is a slight indication that cells with one nucleolar organizer have a longer mitotic cycle; but more data are required to settle this point.

It seems more likely that the sensitivity differences are related to synthesis periods in interphase.

Howard and Pelc[12] have estimated that in root meristem cells of *Vicia faba*, DNA synthesis occupies 6 hr. and ends 8 hr. before the beginning of visible prophase; and in cells subjected to X-rays at specific times (which are spanned by my own fixations) mitosis is delayed by 4 hr. In the present experiments, using the timing of Howard and Pelc, DNA synthesis probably ends about 14 hr. before metaphase. If so, cells with extra nucleolar organizers show their difference in sensitivity shortly after synthesis is completed. Here it is interesting to note that Thoday[15] has related important changes in the types of breakage and reunion in *Vicia* to the timing of DNA synthesis by Howard and Pelc.

In my experiments, the differences in sensitivity last less than 10 hr. Possibly this covers a second and later synthesis period, in which the nucleolus plays an important part, between the end of DNA synthesis and the beginning of prophase. The occurrence of such an additional period has already been inferred[12].

It is difficult to imagine how the presence of extra nucleolar organizers could reduce initial breakage. It seems more likely that they favour a higher frequency of restitution. Unfortunately, the types of reunion seen at metaphase are of little use in solving this problem.

Similar results have been obtained by La Cour[8] in *Hyacinthus*, where breakage is lowered in a trisomic variety having an extra nucleolar chromosome. In *Vicia* the fact that a high proportion of the extra nucleolar organizers are present in active micronuclei shows that they act through the cytoplasm.

At present there is no evidence that other chromosome elements can affect sensitivity. Although the nucleolar organizers are essential in this system, the acentrics which carry them also carry small but varying amounts of heterochromatin; the relative importance of this heterochromatin is therefore still uncertain. However, a more detailed study of the frequency with which these acentrics form viable micronuclei should throw more light on this problem.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Rock Magnetism in Iceland

Recent studies by J. Hospers[1] have revealed that Icelandic basalts fall into two groups with respect to their remanent magnetization. In one group the direction of magnetization is close to the present direction of the geomagnetic field. In the other group the magnetization has the opposite direction. Intermediate directions are rarely found. Studies made by A. Roche[2] have revealed the same fact for French basalts of Quaternary and Tertiary age. These findings have been interpreted in terms of repeated reversals of the geomagnetic field.

For an extensive survey of the two magnetic groups it is necessary to use a quicker and more convenient method than that of conventional magnetometer measurements in order to distinguish one group from the other. It is of primary importance to be able to tell in the field to which group a certain rock formation belongs.

For this purpose we have used an ordinary field compass. A specimen of convenient size is removed from the rock, and its magnetic polarity tested by moving it close to the compass. In most cases the permanent magnetization of basalt is strong enough to give an easily detected deflexion of the magnetic needle. If the north magnetic pole of the specimen points downwards when this is placed in the original position, the specimen is normally magnetized; if it points upwards it is inversely magnetized.

During the year 1954 we examined several thousand specimens distributed over all parts of Iceland. This study has revealed close correspondence of the magnetization with distinct formations. As a rule, specimens taken from the same volcanic formation all have the same polarity.

Exceptions are found in old basalts where a weak and irregular magnetization sometimes prevents the determination of the polarity of the rock formation as a whole. In conglomerates the rounded pebbles usually show a random distribution of polarization; but occasionally conglomerates with uniform polarization have been found in the older rocks. In recent conglomerates which have been under the influence of hot-spring water normal polarization has been found prevailing in basalt pebbles taken at the surface, although the underlying basaltic layers which have been exposed to the same temperature (*c.* 100° C.) retain the original inverse magnetization as revealed by cores from bore-holes. It therefore seems likely that the change in magnetization of the pebbles is due to chemical alteration promoted by presence of the oxygen of the air. Irregular magnetization in old basalts may have a similar explanation.

On level ground it is customary to find a uniform magnetization extending over an area of some tens or hundreds of square kilometres.

In basaltic mountains built up of nearly horizontal lava-flows, of 5–10 m. thickness each, we find layers of normal and inverse magnetic polarization respectively one on top of the other. Each of these magnetic ensembles contains from several to more than one hundred lava-flows. The boundaries between the magnetic ensembles are distinct and usually follow a layer of sediments separating the basaltic flows.

The total thickness of sections we have tested in different parts of Iceland is 21,000 m. 10,000 m. have been found normally magnetized, 9,000 m. inversely magnetized and 2,000 m. irregularly magnetized.

From this we conclude that the amount of inversely magnetized basalt in Iceland is of similar magnitude to that of the normally magnetized.

As to area, we find a greater extension of normal than of inverse polarization; but this is only due to the fact that a large part of the country is covered by tuffs and lavas younger than Lower Quaternary and all these young rocks are found normally magnetized.

Between the basaltic lava-flows there are frequently thin layers of red baked clay which is just as strongly magnetized as the basalt itself. This clay always shows the same polarization as the basalt on top of it.

Basaltic dykes usually show a regular polarization. The same polarization is always found in the country rock close to the dyke regardless of whether it cuts through basalt or clay.

This has been tested for all combinations of dyke and country rock magnetization.

To explain the fact that widely different materials which were erupted or heated during certain periods of time all acquire an inverse magnetization, we see no other possibility than to assume that the magnetic field of the earth had the opposite direction of what it has to-day. Our observations indicate that there are found in the Icelandic basalts at least three periods, during which there was reversion of the magnetic field. The last period of reversion seems to cover the Pliocene–Pleistocene boundary and may thus be compared with the last period of inverse magnetization in France, as found by Roche. If parallelism with Roche's findings is assumed for the older units, the Icelandic rocks tested by us reach back to the Oligocene.

This field work will be further extended in order to map the distribution of the various magnetic ensembles. In continuation of the field survey exact laboratory measurements of rock magnetism with an accurate magnetometer are now in progress.

Trausti Einarsson
University of Iceland,
Reykjavik.

Thorbjörn Sigurgeirsson
National Research Council,
Reykjavik.

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Geophysical Work in North Greenland

The purpose of this communication is to record briefly those results of the geophysical work of the British North Greenland Expedition which would be of interest to others visiting this area.

One of the aims of the work was to measure thicknesses of ice by seismic reflexion methods at points along the traverses indicated on the map, Fig. 1. In the first year of the Expedition (1953) a 6-channel reflexion unit was used, in the second a 12-channel unit.

Except near the extreme eastern edge of the ice-sheet, no definite reflexions from an ice-bedrock interface were detected east of a line running approx-

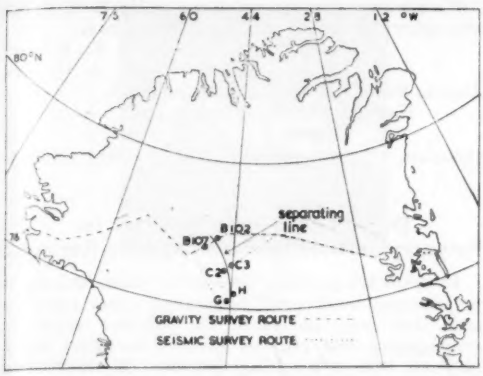

Fig. 1. Map of North Greenland showing position of line separating reflecting and non-reflecting seismic areas

imately 330°, the position of which is shown on the map. Definite reflexions were obtained west of the line, the three stations closest to it and at which reflexions were detected being: *B* 107 (77° 40′ N., 47° 56′ W.), *C* 2 (77° 02′ N., 45° 08′ W.) and *G* (76° 13′ N., 44° 22′ W.). East of the line, no reflexions were detected at *B* 102 (77° 56′ N., 46° 27′ W.), at *C* 3 (77° 12′ N., 44° 02′ W.) or at *H* (76° 26′ N., 43° 36′ W.). The distances between the pairs of stations *B* 107 and *B* 102, *C* 2 and *C* 3, *G* and *H* are all approximately 35 km.

Various field techniques were employed at each station. At those west of the line the best reflexions were obtained with Poulter air-pattern shooting, although reflexions were obtained with single air shots. Using identical shooting and geophone patterns at stations east of the line, no reflexions were obtained.

The altitudes of these six stations are between 2,516 metres (station *B* 102) and 2,780 metres (station *G*). The ice thicknesses at *B* 107, *C* 2 and *G* are approximately 2,700, 2,650 and 2,950 metres, respectively. West of the line, the bedrock surface rises to the west, the average slope being about 10 m. per km.

Values of gravity were determined along a traverse passing through stations *B* 102 and *B* 107. A plot of the values of the free-air anomalies shows a discontinuity between the station at 77° 54′ N., 46° 37′ W. and that at 77° 53′ N., 46° 46′ W., superimposed on the regional trend of the anomalies. The magnitude of the jump is approximately 4 mgal., the anomaly being algebraically greater to the west. Between these two stations the mean horizontal gradient of the free-air anomaly is thus 0·8 mgal. per km., compared with a gradient for the regional trend of about 0·15 mgal. per km. However, larger gradients of the free-air anomaly are found in other parts of the ice-sheet, both east and west of the line separating the areas where seismic reflexions are and are not obtained.

A full discussion of these results will be given elsewhere.

R. J. M. Bruce
N.V. De Bataafsche Petroleum Maatschappij.
C. Bull
Department of Geodesy and Geophysics,
Downing Place, Cambridge.
March 22.

Electrons in Solutions

The possibility of a stable bound state of the electron in water and in similar media is of importance in many fields of chemistry in which electron-transfer phenomena play a part. In photochemistry and in radiation chemistry particularly, there have been recently several discussions of this problem[1]. Since no definite conclusions have been reached, we have recently reconsidered the problem (Bareli, K., and Stein, G., unpublished work). Several independent methods used by us point to the same conclusion, namely, that the aqueous medium does possess an electron affinity. Regarding the quantitative value of the energy of binding, two hypothetical bound states of the electron in water were indicated. Some of the methods used by us indicated that in the first of these, which may be denoted by $e_{aq.}$, the electron is bound with an energy of approximately 25 kcal./mole. In the other hypothetical state, which was obtained by the use of a different approach and which may be denoted by $H_2O\bar{a}_{q.}$, the electron would be bound with an energy of the order of 70 kcal./mole.

Each of the methods used was sufficiently uncertain to make further experimental support very desirable. In 1934 Fernelius recorded an observation[2] which hinted at the possibility of obtaining such experimental evidence. In an attempt to obtain the most favourable experimental conditions, we have now distilled metallic potassium *in vacuo* and studied the reaction of the freshly distilled potassium in the same vessel cooled to − 10° C. in the total absence of oxygen with water at 0° C. During the reaction the temperature did not rise above − 5° C. A solution results, the spectrum of which is shown in Fig. 1. The colour decays by two processes: (*a*) thermally, with the evolution of hydrogen, presumably according to the stages:

(1) $K \rightarrow K^{+}_{aq.} + e_{aq.}$

(2) $e_{aq.} + H^{+}_{aq.} \rightarrow H_{aq.}$

(3) $2\,H_{aq.} \rightarrow H_2$

(*b*) on the admission of oxygen, according to

(4) $e_{aq.} + O_2 \rightarrow O_2\bar{a}_{q.}$

with the spectrum changing accordingly.

Using metallic sodium under similar conditions, less-pronounced though similar phenomena occur.

When the freshly distilled metals reacted with cooled absolute methanol or ethanol at − 40° C. in the total absence of oxygen, bluish-coloured solutions were obtained. The colour decayed by the two processes described above and also by a third

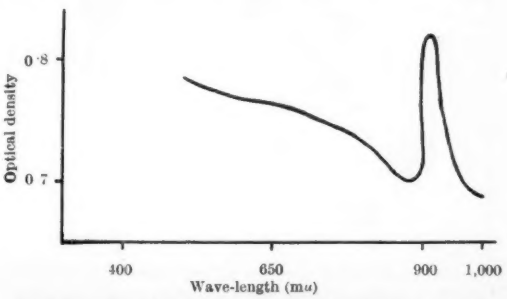

Fig. 1. Absorption spectrum of potassium in water at − 3° C., in the absence of oxygen

process, accompanied by a rapid evolution of hydrogen, when water was added to the coloured absolute alcoholic solutions.

The properties of these systems are being investigated and we hope to publish full details in the future.

Joshua Jortner
Gabriel Stein

Department of Physical Chemistry,
Hebrew University,
Jerusalem.
March 3.

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The Hydrogen Atoms in Alpha-Resorcinol

As the first example of the location of hydrogen atoms in aromatic molecules by single-crystal neutron diffraction methods, we have studied α-resorcinol, $C_6H_4(OH)_2$. This substance was examined with X-rays in 1936 by Robertson[1], who located the carbon and oxygen atoms in the structure, concluding that there were O—H—O bonds of lengths 2·66 and 2·75 A. which formed infinite helices throughout the crystal.

Our preliminary Fourier projection of the neutron scattering density on the (001) plane is given in Fig. 1, which shows a resorcinol molecule, inclined at 61° to the plane of the projection, together with the hydroxyl groups of neighbouring molecules. All the hydrogen atoms, which have a negative scattering amplitude for neutrons, are clearly defined. Those which are attached to the benzene ring have a C—H distance of approximately 1·1 A. The hydrogen bonds which link the molecule to its neighbours are non-symmetrical, with the proton about 1 A. away from the nearer oxygen atom.

We are at present refining the structure by difference syntheses in order to determine these bond-lengths accurately, and full details of this work will be published in due course.

Fig. 1. A projection on the (001) plane of the neutron scattering density for α-resorcinol. The full lines are positive contours (carbon, oxygen): the dotted lines are negative contours (hydrogen)

We acknowledge the assistance of Mr. S. A. Wilson, who grew our single crystals of resorcinol.

G. E. Bacon
N. A. Curry

Atomic Energy Research Establishment,
Harwell, Didcot, Berks.
March 7.

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Detection of Free Radicals in Polyacrylonitrile by Paramagnetic Resonance

Evidence has been presented[1] that, during the polymerization of vinyl monomers under conditions such that precipitation of the polymer occurs, the propagating free radicals become occluded by the polymer with a resulting decrease in their accessibility for reaction. The effective rate-coefficients for the free radical reactions, particularly that of chain termination, are thus reduced, giving rise to the characteristic kinetic features observed in heterogeneous vinyl polymerizations. In the case of acrylonitrile, extreme degrees of occlusion may be reached, leading to the presence in the polymer of trapped radicals for which the propagation and termination coefficients are practically zero. The concentration of these radicals has been estimated by reaction with αα-diphenyl β-picryl hydrazyl[2]. We now wish to report the detection and estimation of trapped radicals by observation of the paramagnetic resonance absorption spectrum of the polymer. This method has already been employed to detect radicals in activated carbon and other carbonaceous solids[3,4], and also in gel systems prepared from cross-linked vinyl polymers[5].

Acrylonitrile was polymerized photochemically in a tube of ¼ in. diameter with di-*tert.*-butyl peroxide (10 per cent v/v) as catalyst. The rate was 7×10^{-3} mol.lit.$^{-1}$ sec.$^{-1}$. After 20 per cent conversion the unchanged monomer and catalyst were distilled off in vacuum and the tube sealed. The paramagnetic resonance absorption spectrum of the polymer was observed at room temperature at a wave-length of 3 cm., and also at 90° K. and 20° K. at 1·25 cm. The tube containing the polymer was first inserted into an H_{012} 3 cm. wave-length rectangular resonant cavity, when an absorption line with a width of about 20 gauss and a spectroscopic splitting factor of $2{\cdot}00 \pm 0{\cdot}01$ was observed, using a normal crystal-video system of detection. Comparison of the integrated intensity of the signal with that obtained from low-temperature carbon samples calibrated directly against diphenyl picryl hydrazyl[4] indicated that the concentration of unpaired electrons present in the polyacrylonitrile was about 10^{17} per ml. (based on the initial monomer volume). The concentration of free radicals determined by the chemical method using diphenyl picryl hydrazyl may be seen from a short extrapolation of the line in Fig. 3 of ref. 2 to be approximately 8×10^{-5} mol.lit.$^{-1}$ or 5×10^{16} radicals per ml. The agreement between the two completely independent methods of radical counting is highly satisfactory. Even under the favourable conditions used in these experiments, only about 1–2 per cent of the total number of radicals generated become trapped; hence it is clear that no kinetic treatment of the polymerization which embodies termination predominantly by radical occlusion is valid.

The effect of admitting air to the polyacrylonitrile sample was also studied by breaking off the tip of

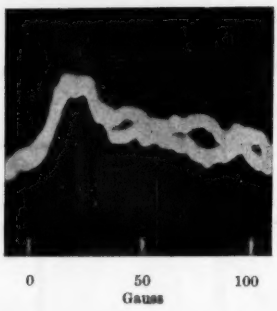

Fig. 1

the tube while observing the signal. No immediate change was noticed; but the intensity was found to fall gradually, until after half an hour the signal was lost in the noise. This rather slow reduction of signal strength on admission of air was confirmed in the low-temperature experiments. In these, some of the material was packed into a small 'Distrene' cup immediately after contact with air, and then studied at liquid-oxygen and -hydrogen temperatures. A standard type of low-temperature H_{111} cylindrical cavity was used. The signal obtained at 20° K. from such a sample is illustrated in Fig. 1; at this temperature no noticeable change in intensity with time was observed. Material from the same sample was again studied a few hours after the initial contact with the atmosphere, after standing at room temperature, when no trace of the absorption line could be found. The destruction of the trapped radicals following contact with air has previously been deduced from studies of the fast reaction[1]. It may result from reaction with oxygen to form

$$\diagdown\!\!\diagup C\text{—}OO\cdot$$

radicals, and subsequent splitting off of $HO_2\cdot$ radicals which are then free to interact to form non-radical products. The formation of $HO_2\cdot$ may be a comparatively slow process requiring appreciable activation energy.

One other feature of interest is that the line-width appears to be greater at 20° K. than at 90° K. This may suggest a form of 'motional narrowing' interaction[6] at the higher temperature.

These studies are being continued, and will be extended to include the polymerization of other monomers.

C. H. Bamford
A. D. Jenkins

Courtaulds, Ltd.,
Research Laboratory,
Maidenhead, Berks.

D. J. E. Ingram
M. C. R. Symons

Department of Electronics,
Department of Chemistry,
University of Southampton.
March 17.

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Melting Behaviour of Crystalline Polymer Fibres

In a recent study of the specific heats of 6·6 and 6·10 nylons, Wilhoit and Dole[1] obtained melting curves in which the peak for drawn filaments occurred at a lower temperature than for the corresponding undrawn filaments. They considered that the forms of these curves suggested that in 6·6 nylon drawn yarn, part of, if not all, the nylon melts and then perhaps recrystallizes and melts again. Alternatively, it was suggested that a considerable fraction melts at one temperature and a significant fraction at a higher temperature.

Using differential thermal analysis, we have now shown that, in the melting of drawn yarns of certain crystalline polymers, two distinct heat absorptions occur in separate temperature regions. These two heat changes appear to accompany respectively the disorientation of crystalline regions and then actual fusion of the crystallites, rather than the transformation or melting of polymorphs. The melting curves for the polymer in bulk and for the undrawn filaments indicate a single broad range of heat absorption.

Typical forms of differential heating curves obtained during the melting of 6·6 nylon filaments, using heating-rates of 0·5–1·5 deg. C./min., are shown in Fig. 1.

The development of the broad heat absorption peak 240–265° C. for undrawn 6·6 nylon yarn into two distinct peaks 240–257° C. and 259–265° C. on drawing has been followed, using a series of melt-spun yarns cold-drawn up to extensions of about 400 per cent; ΔH (240–265° C.) values depend upon the degree of drawing and are, in general, greater for the drawn yarns.

On slowly heating drawn 6·6 nylon yarn to 258° C. and cooling it slowly to room temperature, the yarn retains its physical form and shows no sign of fusion. However, the X-ray diffraction pattern, the optical

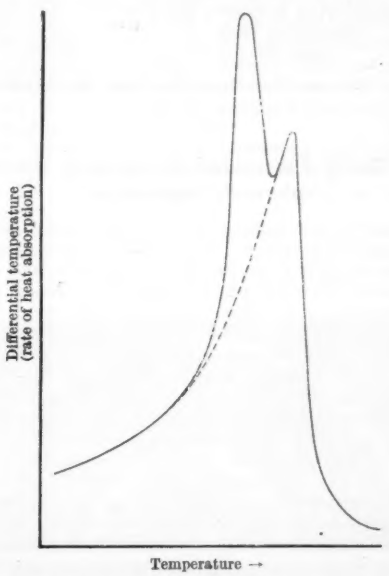

Fig. 1. Differential heating curves for melting 6·6 nylon fibres; — — —, undrawn yarn; ———, drawn yarn

birefringence and the melting curve all revert to those characteristic of undrawn yarn, with random orientation of crystalline regions. We consider, therefore, that the heat absorption shown by drawn 6·6 nylon yarn in the range 240–257° C. is associated with disorientation of the crystalline regions and that, because of the strong interchain forces existing in the 6·6 nylon crystal structure, actual fusion of the crystallites does not occur until slightly higher temperatures are attained.

The occurrence of two heat changes in separate temperature ranges has also been noted by us on melting drawn fibres of polyethylene terephthalate, 6 and 6·10 nylons, certain co-polyamides and, to some extent, the polyurethane, 'Perlon U'. Drawn fibres of polyethylene and 11 nylon show only a single broad heat absorption-range in which disorientation and melting occur simultaneously.

The actual shape of the melting curve, at fixed heating-rates, of drawn yarns showing the two heat changes in the melting range depends on the crystallinity and the degree of orientation of the crystallites. Although structural changes occur in the yarns during the course of heating up to the melting temperatures, the melting curves are a valuable method for characterization. Small differences in the degree of orientation of highly oriented yarns such as polyamide or polyester tyre-cords are detected more readily than is possible by X-ray methods. Furthermore, the method is sometimes applicable when the yarn is in a form which precludes X-ray or optical methods, for example, when highly twisted or woven. A disadvantage is that the sample is necessarily destroyed. The method has been applied to problems which require a study of changes in fine structure of nylon yarns.

Fuller details of this work will be published elsewhere. I wish to thank British Nylon Spinners, Ltd., for permission to publish this communication.

T. R. White

Research Department,
British Nylon Spinners, Ltd.,
Pontypool, Mon.
Jan. 20.

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An Easily Assembled Continuous Electrophoresis Apparatus

Designs for apparatus for continuous electrophoresis employing an electrical field perpendicular to gravity flow have included anticonvective media supported between plates[1], and filter paper as an anticonvective medium supported between plates[2] and hung like a curtain[3]. Construction of such equipment has tended to discourage the use of this method of isolation, particularly when exploratory experiments are necessary to assay the applicability of continuous electrophoresis to a particular problem.

The design described in this communication requires little special equipment and may be assembled from glassware usually found in the laboratory. A standard 'Pyrex' cylindrical jar (6 in. × 8½ in.) is used for supporting a sheet of filter paper, the sample container, the buffer solution, and the buffer flow system (Fig. 1). The sheet of filter paper serrated at the lower edge is wet and wrapped around the cylinder in a manner to exclude bubbles between the cylinder and filter

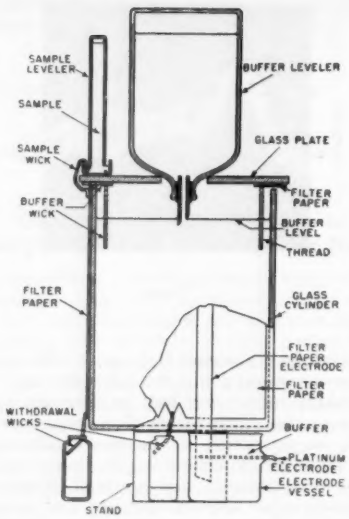

Fig. 1. Drawing of continuous electrophoresis apparatus

paper. For a single sample, a filter paper sheet with a length (when wet) of ¼ to ½ in. less than that of the outer circumference of the cylinder is used. The paper sheet is allowed to project about ⅛ in. above the edge of the cylinder and is folded over to make contact with the buffer wick. The buffer wick is the type designed by Irreverre and Martin[4] for use in descending chromatography. A glass plate ¼ in. thick is placed on top of the buffer wick. This plate with a 1½-in. diameter hole drilled in its centre acts both as a press to keep the bent edge of the filter paper sheet and the buffer wick in good contact and also as a support for the inverted bottle containing the buffer solution. The inverted bottle of buffer, when equipped with a tube of the correct internal diameter (approximately 11 mm.), serves to keep constant the level of the buffer inside the cylinder. The solution of sample with its own levelling system is also supported on the glass plate. The usual wick carries the sample solution to the filter paper. Surface tension is sufficient to hold the sample wick in contact with the paper. The two electrode wicks, each consisting of a stack of three strips of filter paper ½ in. × 1 ft., are wet and placed in contact with the wet filter paper with the freely hanging ends of the electrode wicks dipping into the electrode vessels. Samples are withdrawn from the serrations cut in the filter paper with wicks of wet cotton thread approximately 1 mm. in diameter held in place by surface tension. The whole apparatus is covered with a plastic bell cover made from a sheet of 'Lucite', 24 in. × 46 in. × ⅛ in.

Our original interest in the use of this method was in separating amino-acids. An example of one experiment is illustrated in Fig. 2, where a mixture of 0·02 *M* of each of the amino-acids, alanine, arginine, glutamic acid, glycine and valine, were separated at *p*H 5·2 into the acid, basic and neutral species. The buffer was ammonium acetate, ionic strength 0·01; the current was 8 m.amp.; the solvent flow was 10 ml. per hr. through a total of twenty-five serrations spaced ½ in. apart; and the sample flow was 0·2 ml. per hr.

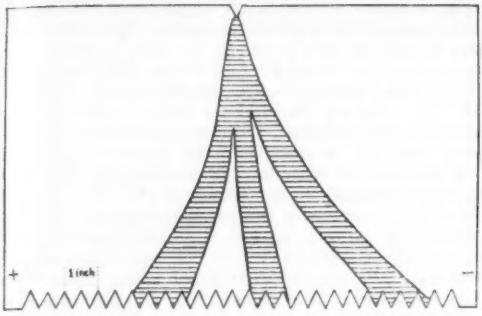

Fig. 2. Illustrative experiment on acid, basic and neutral amino-acid mixture

Apart from the ease of assembly and low cost, the apparatus has the following advantages: (1) buffer flow may be controlled by varying the number of threads in the buffer wick and by changing the buffer level; (2) the cylinder of buffer lowers the steady-state temperature; for example, with a current of 15 m.amp. and a room temperature of 28° C., the steady-state temperature was 32° C.; and (3) two samples may be run simultaneously by wrapping the sheet of filter paper completely around the cylinder. One electrode wick is placed over the joined edges of the filter paper, while the other electrode wick is placed on the opposite side of the cylinder. The result is a symmetrical arrangement allowing the use of two different samples.

H. A. Saroff

National Institute of Arthritis and Metabolic Diseases,
National Institutes of Health,
Public Health Service,
U.S. Department of Health,
Education and Welfare,
Bethesda, Maryland.
Dec. 21.

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A Simple Paper Chromatographic Technique for the Study of Free Metabolites of Tissues and Body Fluids

Buzzati-Traverso and Rechnitzer proposed a simple chromatographic technique for taxonomic studies on fishes[1]; Buzzati-Traverso applied it also to genetic studies on *Drosophila*[2]. In the original technique, the tissues were simply squeezed on filter paper, dried and chromatographed. The method was used almost as such by some authors for taxonomic studies on land snails[3], mosquitoes[4], and for investigating several mouse and tumour tissues[5]. The present method, although starting from the same principle, was developed in a rather different manner. It does not utilize fresh tissues, but tissues which have been dried and powdered. By this means it is possible to use an accurately known amount of tissue, independently of its water content, and to extract completely the free metabolites from the broken cells; furthermore, the samples used may be larger, thus allowing the detection of metabolites which may be present in amounts too small to be detected by the use of small pieces of tissue.

This procedure was made possible by employing a modified paper-disk chromatographic technique. A sheet of Schleicher and Schull 2043 *B* filter paper is sandwiched between two glass plates 25 cm. × 25 cm. One of these plates has a central hole 6 mm. in diameter. The tissue sample, taken from exsanguinated animals, is dried at 100° C. This temperature of desiccation has been found to give the best results, and seems not to alter most of the free metabolites studied. For serum, half a millilitre is dried in the same manner. For metabolites unstable to heat the tissue may be lyophilized. The dry tissue or serum is then reduced to a fine powder by grinding it in a mortar; 5–10 mgm. is weighed (for serum 15–20 mgm.) and evenly distributed in the hole of the glass plate. A small filter-paper disk, 6 mm. in diameter, is gently pressed on the powder to keep it in place, and is lightly wetted with the solvent. The plate is then inverted over a small dish containing the wick, the base of which is immersed in 10 ml. of the solvent. The wick consists of a cone of filter paper the base of which has the same diameter as the internal diameter of the dish and the height of which is about 2 mm. greater than the dish itself.

When inverting the plate over the dish, care must be taken that the tip of the wick adheres exactly to the centre of the disk supporting the material. The small, closed chamber formed by the dish and the plate soon becomes saturated with the solvent vapour, and the solvent flows regularly through the material under study, extracting its free components and chromatographing them.

The solvent is allowed to flow 10 cm. from the centre. It takes about seven hours to reach this distance when the mixture *n*-butanol / water / acetic acid (100 : 100 : 24) is used, and about twelve hours for the mixture tertiary-butanol / formic acid / water (70 : 15 : 15). This distance must be carefully controlled, in order to be able to compare directly the different chromatograms. After drying, the chromatograms are observed under Wood's light to detect their fluorescence patterns; then they may be cut in sectors and on each sector a different reaction may be performed.

The relative position of the different bands in the ultra-violet, the ninhydrin reaction and other reactions, may be, in this manner, established by direct comparison.

The method allows very good separations, perhaps because the solvent flows straight through the substance to be chromatographed (Fig. 1), and it seems

Fig. 1. Autoradiograph of chromatograms of rat thyroid 16 hr. after intraperitoneal injection of 300 μc. of iodine-131. Each half of the figure represents the thyroid of a single animal. Solvent: normal butanol/water/acetic acid (100 : 100 : 24)

to be susceptible of the widest application both for natural and unnatural metabolites.

Several problems are now under investigation in our laboratory by its use; for example, the amino-acid composition of different normal organs, comparison between normal and tumour tissues and sera and the distribution of labelled amino-acids. We are also elaborating a method for a quantitative estimation of the free amino-acids separated by circular paper chromatography.

Giovanni Ceriotti

Centro Tumori, Busto Arsizio,
Varese, Italy. Jan. 17.

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Chromatography of Serum and some other Proteins on an Anion-exchange Resin

Cation-exchange resins have proved suitable as adsorbents for chromatographing a number of proteins (see a review by Zittle[1]). Last year, however, Sober and Peterson[2] reported the use of an anion-exchanger as an adsorbent in protein chromatography. These authors used 'DEAE-Polycel' (prepared from cellulose) for the chromatographic purification of kidney amidase and some other enzymes. The purpose of the present communication is to describe another system for anion-exchange chromatography of proteins which appears to be useful for a number of rather different proteins.

The resin used was 'Dowex 2', 200–400 mesh, brought to the chloride form by washing with 1 *N* sodium chloride. After an experiment, the column is regenerated with 1 *N* hydrochloric acid and then washed with starting buffer solution until the *p*H is unchanged after passing through the resin. Tris (hydroxymethyl) aminomethane hydrochloride (Sigma Chemical Co. Tech. Bull. 106) has been used as the buffer system. Since *p*H control is particularly important in protein chromatography, it is an advantage to have a cation with buffer capacity when working with an anion-exchange resin.

As in the studies of Tiselius[3] with calcium phosphate columns, elution of different proteins takes place in narrow intervals, so that a comparatively small increase in buffer concentration brings the R_F from about zero to about 1·0. The experiments recorded here were performed in such a way that the proteins were adsorbed at low ionic strength and eluted by a stepwise increase in the buffer concentration, keeping the buffer *p*H constant at 7·2. The dimensions of the column were 18 cm. × 1·5 cm. Fractions were shifted every 30 min., which gave fraction volumes of about 3·3 ml. All experiments have been run in a cold room at 4°.

Fig. 1 shows results of an experiment with serum from a patient with prostatic cancer. The serum had been stored for two weeks in the frozen state. The amount applied was 0·5 ml. of serum dialysed against 0·02 *M* tris (hydroxymethyl) aminomethane buffer of *p*H 7·2. (During the dialysis some of the globulin material was precipitated and removed by centrifugation.) As can be seen from the figure, elution was first carried out with 0·02 *M* buffer and then with stepwise increases to molarities of 0·1, 0·2, 0·4 and 1·0 of buffer, keeping the *p*H constant at 7·2. The amount of protein in the different fractions was followed by the extinction at 280 mμ measured in a Beckman *DU* spectrophotometer using 1-cm. cells. It is well known from the work of Gutman and Gutman[4] that prostatic cancer leads to highly increased values of the acid phosphatase activity in serum. For this reason, the different fractions from the experiment were tested also for acid phosphatase according to a modification of the method of Bessey *et al.*[5]. As seen in Fig. 1, most of the phosphatase activity (82 per cent of the activity applied) is found in the third zone. Attempts have been made to identify the different zones from the column by using paper electrophoresis. From these experiments it is clear that the second peak (tube 8 in Fig. 1) consists of almost pure albumin and the fourth peak (tube 21 in Fig. 1) of a well-defined γ-globulin fraction. The third peak is probably α_1- and α_2-globulin. The uncertainty here comes from the difficulty of concentrating the material without denaturation. However, zone electrophoresis experiments with a cellulose column, by the method of Flodin and Porath[6], has shown that the phosphatase activity is not associated with the albumin or the γ-globulins; but due to the instability of the enzyme at alkaline *p*H, electrophoresis experiments failed to give further information. Fig. 1 also shows that the maximum amount of ultra-violet-absorbing material comes in tube 13, while the enzyme maximum is in tube 14. It is thus likely that other conditions can give a better resolu-

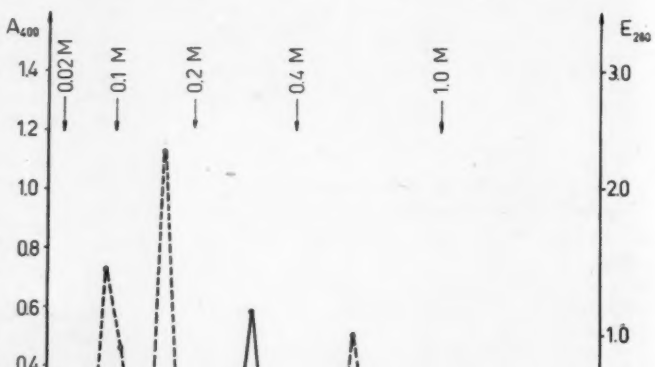

Fig. 1. Chromatography of serum from a patient with prostatic cancer. Open circles represent the extinction at 280 mμ and solid circles the acid phosphatase activity expressed in arbitrary units. The second peak consists of almost pure albumin and the fourth of a γ-globulin fraction

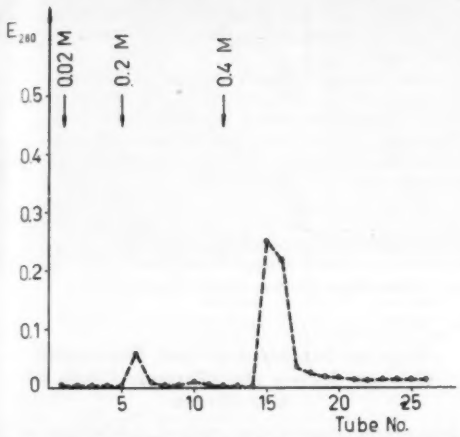

Fig. 2. Chromatographic experiment with a commercial sample of human serum albumin. The open circles represent extinction at 280 mμ. For further details, see text

tion of this zone. Finally, the first peak contains β-globulin and, in addition, at least some γ-globulin, which are not adsorbed under the conditions used here.

A commercial sample of human serum albumin has been studied on the same column as used in the serum experiment and under similar conditions. The result can be seen from Fig. 2. The main peak containing 52 per cent of the amount applied is not eluted until the buffer concentration is increased to 0·4 *M*. However, rechromatographing the albumin eluted at this buffer concentration only gave one narrow zone and a recovery of 87 per cent, calculated on the basis of the extinction at 280 mμ. These experiments make it probable that the commercial sample was no longer in the native state.

With the same chromatographic technique it has been possible to purify a vegetable acid phosphatase from a crude extract (Anagnostopoulos and Boman, unpublished work). This enzyme is not adsorbed on 'Dowex 50' and is thus chromatographically different from prostatic phosphatase[7]. Some purified proteins, prostatic phosphatase, hæmoglobin, phycoerythrin and phycocyanin have also been studied and found to give narrow and well-defined zones. These proteins are eluted at the concentrations indicated: prostatic phosphatase 0·2 *M*, acid phosphatase from white mustard seeds 0·2 *M*, phycoerythrin 0·4 *M*, phycocyanin 0·4 *M*, all molarities with regard to tris (hydroxymethyl) aminomethane at *p*H 7·2. Hæmoglobin is not adsorbed at this *p*H but at *p*H 8·3, where it is eluted at a buffer molarity of 0·1. However, these concentrations are not necessarily to be regarded as the minimum strengths required for elution, which have not yet been definitely determined.

The work is being continued, and a more detailed report will be published later. I wish to thank Prof. A. Tiselius for his interest in this work.

HANS G. BOMAN

Institute of Biochemistry,
University of Uppsala. March 14.

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Inhibition of Induced Enzyme Formation by Purine Analogues

It has been shown that the enzyme β-galactosidase is inducible in *Staphylococcus aureus* if the organism is supplied with galactose and a mixture of amino-acids; enzyme formation in intact and disrupted cells is markedly stimulated by the presence of glucose and a mixture of purines and pyrimidines[1,2].

The purine analogues 8-azaguanine and 2:6-diaminopurine inhibit formation of the enzyme in intact cells by reducing the rate of synthesis, as shown in Fig. 1. Benzimidazole was slightly inhibitory, but the effects were very variable. The pyrimidine analogues 5-nitrouracil, 5-bromouracil, 2-thiouracil and *iso*cytosine were without effect on β-galactosidase formation. The inhibitory activity of 8-azaguanine could be completely reversed by the addition to the system of either guanine, xanthine or hypoxanthine, but not by uracil, thymine or adenine. 1 mol. of guanine annuls the inhibitory action of approximately 200 mol. of 8-azaguanine. Inhibition by 2:6-diaminopurine was partially reversed by the addition of hypoxanthine but not other purines or pyrimidines.

When *Staph. aureus* is supplied with ^{14}C-uracil, newly formed nucleic acids are found to be radioactive, activity being localized in uracil, thymine and cytosine. During induced enzyme formation, there is a synthesis of ribo- and deoxyribo-nucleic acids which can be measured by the incorporation of ^{14}C-uracil into the two nucleic acid fractions. Concentrations of 8-azaguanine which completely prevent β-galactosidase formation have no inhibitory activity on the synthesis of either ribo- or deoxyribo-nucleic acids, as measured by the incorporation of ^{14}C-uracil into the pyrimidines.

Matthews[3] has shown that 8-azaguanine is incorporated into the nucleic acid of tobacco mosaic virus with a resulting decrease in infectivity of the virus. Cells of *Staph. aureus* in which the induced formation

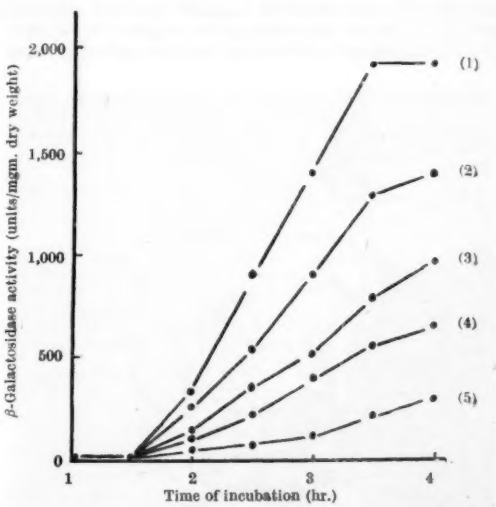

Fig. 1. Effect of 8-azaguanine and 2:6-diaminopurine on β-galactosidase formation. System consisted of *Staph. aureus* (2 mgm./ml.), 17 amino-acids (200 μgm./ml. of each), glucose (1 mgm./ml.), galactose (20 mgm./ml.) in a buffered salts solution. Additions: (1) nil; (2) 2:6 diaminopurine (500 μgm./ml.); (3) 8-azaguanine (10 μgm./ml.); (4) 8-azaguanine (20 μgm./ml.); (5) 8-azaguanine (50 μgm./ml.)

of β-galactosidase has been completely suppressed by 8-azaguanine have been examined by the methods described by Matthews, and it has been found that 8-azaguanine has been incorporated into ribo- but not deoxyribo-nucleic acid. It has been suggested that nucleic acid is concerned in the formation of induced enzyme[2,4]; the present findings are consistent with that suggestion, as incorporation of 8-azaguanine into the nucleic acid might be expected to impair its function equally in protein synthesis as in virus formation.

E. H. Creaser

Medical Research Council Unit
for Chemical Microbiology,
Department of Biochemistry,
University of Cambridge.

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Bacterial Utilization of Cyanide

During experiments to determine the fate of potassium cyanide contained in sewage during treatment on percolating filters, a bacterium was isolated capable of growing on silica gel medium containing only potassium cyanide as a source of nitrogen and carbon; traces of iron, copper and phosphate were also present. The organism, which consisted of Gram-positive branching filaments approximately 1μ in diameter, some of which were broken up into bacillary segments, grew on solid medium as a hard, white and powdery colony reaching a maximum of 1 mm. in diameter after incubation for seven days at 28° C. Aerial hyphæ and conidia are present (Fig. 1); but the latter are probably not true reproductive bodies as the organism is killed by drying. The organism is aerobic and a strict autotroph, growth being inhibited in culture by the presence of agar or peptone. It can utilize concentrations of cyanide up to 15 mgm. per 100 ml., but appears to grow best on cyanide concentrations of approximately 4 mgm. per 100 ml. The bacterium was difficult to culture, growth being slow and sparse; but it exhibited surprising activity, a few colonies being able to utilize more than 0·5 mgm. cyanide per day.

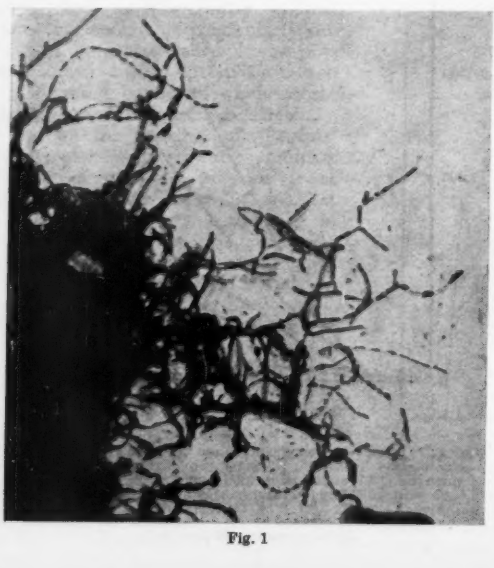

Fig. 1

Ammonia is produced, apparently quantitatively, from cyanide by the growth of the organism; the fate of the carbon is not yet known.

The organism has been provisionally classed among the Actinomycetaceae, and investigation of its biochemical activity is proceeding.

G. C. Ware
H. A. Painter

Water Pollution Research Laboratory,
Elder Way,
Stevenage, Herts. Jan. 12.

Vaginal Sulphhydryl and Disulphide Groups during the Œstrous Cycle of the Mouse

Keratinization of the vaginal epithelium of the mouse occurs during the œstrous cycle. In view of the regular periodicity of this process, it was thought profitable to examine some of its associated histochemical characteristics. The occurrence of —SH and —SS groups in the œstrous vaginal epithelium of the rat has been previously noted[1]. No record of the variations in the distribution of these groups during the normal œstrous cycle appears to exist.

Vaginæ were removed from thirty white mice and fixed for 24 hr. in a solution of 1 gm. trichloracetic acid dissolved in 100 ml. of 80 per cent alcohol; they were embedded in paraffin and sectioned at 7μ. The stages of the cycle were determined from *M.F.*4 (Gurr's vaginal smear stain) and hæmatoxylin and eosin preparations in accordance with the description and terminology of Allen[2]. Sulphhydryl and disulphide groups were demonstrated by the Barrnett and Seligman[3] and the Chèvremont and Frédéric[4] ferricyanide procedures. The ferricyanide procedure was adapted to the study of —SS groups by comparing preparations, previously reduced with thioglycollic acid[5], with corresponding —SH group preparations (C. W. M. Adams, personal communication). Controls were incubated for 3 hr. in saturated aqueous mercuric chloride to inhibit —SH groups.

At the beginning of dicestrum, slight positive reaction for the —SH group was found in the cytoplasm of all epithelial cells; this was most marked in the basal layer. The nuclei showed a negative reaction. During later dicestrum, the most intense —SH group positivity was found in the deepest two to three layers of the epithelium; the superficial layer of cells showed no reaction, although between them there was a definite positive reaction (Fig. 1). These superficial cells do not become keratinized, but remain throughout procestrum and early œstrum as the 'swollen' cells of the vaginal wall[6]. No —SS groups could be detected throughout the dicestrous phase. In early procestrum the deepest seven to eight layers of the epithelium showed slight —SH group reactivity, while the superficial cells, as in late dicestrum, showed no reaction. The intermediate zone of squamous transformation showed intense localization of —SH groups and was also characterized by the first appearance of —SS group reaction; as this zone becomes keratinized during later procestrum, the stratum corneum so formed showed an intense concentration of —SS groups. The corneum and deep layers of the late procestrous epithelium reacted weakly for —SH groups, while the two layers

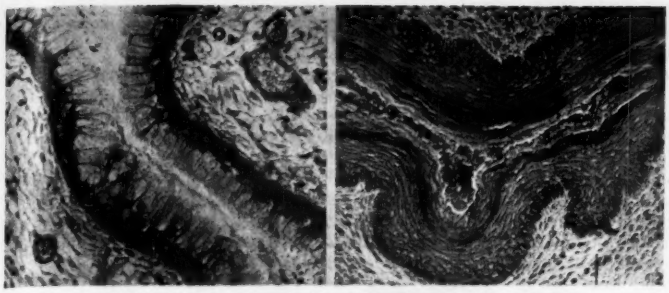

Fig. 1. Distribution of —SH groups in the mid-dioestrous vaginal epithelium. × 100. Barrnett and Seligman procedure

Fig. 2. Distribution of —SH groups in the early œstrous vaginal epithelium. × 5[illegible]. Barrnett and Seligman procedure

of cells immediately beneath the corneum showed intense reaction. The œstrous epithelium showed an intense —SH group reaction in the stratum granulosum; the deeper layers and the corneum were weakly positive (Fig. 2). The —SS group reaction was most intense in the corneum; the stratum granulosum showed slight reactivity. The metœstrous epithelium, following the desquamation of the superficial layers of the epithelium, showed a weak —SH group reaction throughout the cytoplasm of all epithelial cells; no —SS groups were found.

These observations indicate that cyclical variations in the distribution of —SH and —SS groups occur during the œstrous cycle of the mouse. It appears that —SH groups accumulate in the basal layers of the epithelium during dioestrum; later they are found in greatest concentration in the zone of squamous transformation of the early proœstrous epithelium, prior to keratinization during later proœstrum. The present observations further support the well-known concept of a conversion of —SH to —SS groups in the process of keratinization. Experimental and comparative studies are now in progress to elucidate whether or not hormonal factors control these cyclical variations in the distribution of —SH and —SS groups.

We are grateful to Mr. R. Quinton Cox for the preparation of the photomicrographs.

A. W. Asscher
C. J. Turner

Anatomy Department,
London Hospital Medical College,
Turner Street, London, E.1.
Jan. 13.

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Experimental Evidence for an Enzymatic Basis for Itching in Man

The sensation of itching has long been a physiological enigma. Whereas the sensations of pain, touch, heat and cold have always arisen following simple physical stimuli, itching (pruritus) has consistently shown an indifferent response to these physical stimuli, and but a faint answer to chemical stimuli. No one has truly characterized the adequate stimulus for itching. As a result of this, itching has been denied its role as the fifth sensation. Indeed, it has been defined by some as diminutive pain, despite the clinical experience that itch may exceed severe pain in intensity.

The present communication describes a highly specific and presumably physiological method of evoking itching, demonstrating it as a primary sensation, distinct from pain, engendered, not by physical modalities, but by chemical stimuli. In this work the proteolytic enzymes have been found to be the true stimulus for itching.

The investigation began with a demonstration that the active pruritogenic principle of cowhage is a proteinase, mucunain[1]. This led to a study of the role of enzymes in cutaneous sensation. Both crystalline and crude enzymes were introduced into the epidermis in ultra-microquantities, using a single cowhage trichome insertion technique. In this procedure, initial inactivation of the trichomes was achieved by autoclaving at 250° C. for 30 min. The trichomes were then soaked in enzyme solutions, in a dilution ranging from 10^{-1} to 10^{-4}, and later air-dried. The impregnated trichome was introduced manually, using a watchmaker's forceps and a 30 × magnification. The insertion of a single spicule containing active enzyme elicited a distinct mild to intense localized itch, in the absence of any urticaria or other clinical signs. This technique thus avoided the misleading vascular reactions which develop upon ordinary intradermal injection of material. Nevertheless, itching did occur whenever these active agents were injected intradermally (No. 30 needle, 0·02 ml. 10^{-3} to 10^{-4} dil.). Using a wide variety of enzymes, it was found that only members of the proteinase group were active as chemical excitants of itching. Furthermore, only the endopeptidases with activities in the physiological *p*H range showed activity. Exopeptidases, as well as endopeptidases with a *p*H range less than 4 (for example, pepsin), were ineffective, as is seen in the following table:

Active Proteases		Inactive Proteases
Plant	*Animal*	Pepsin*
Mucunain	Trypsin*	Carboxypeptidase*
Papain*	Chymotrypsin*	Aminopeptidase (Leucine)
Bromelin	Pancreatin	Carnosinase
Ficin		Rennin
Fungal proteinase		

Other Inactive Enzymes		
Acid phosphatase	Dehydrogenase, glucose-6-phosphate	Lipase
Alkaline phosphatase	Deoxyribonuclease	Maltase
α-Amylase	Emulsin	Peroxidase
β-Amylase*	β-Galactosidase	Phosphorylase
D-Amino oxidase	β-Glucosidase	Pectinase
Arginase	β-Glucuronidase	Ribonuclease
Carbonic anhydrase	Hemicellulase	Tyrosinase
Catalase	Hexokinase	Urease
Cocarboxylase	Lactase	Uricase
Cozymase		

The crystalline preparations studied have an asterisk. The most active enzymes (mucunain, papain and chymotrypsin) produced itching with the shortest latent period (5 sec.) and the longest duration (30 min.). Increasing the concentration of the enzyme solutions in which the spicules were soaked decreased the latent period and increased the duration and intensity of action. Pain was never observed in any of our experiments.

The mechanism of the pruritogenic action of the proteolytic enzymes is unknown. The enzymes may have a direct effect on the nerve receptor, or may act indirectly by synthesizing or releasing an active compound from the epidermal cells. The long latent period suggests the latter as the more likely. One series of experiments was done, however, indicating that the release of histamine is not the cause of itching, despite the fact that proteolytic enzymes, for example, papain, may act as histamine liberators[2]. It was found that histamine and the potent histamine liberator, '48/80', never produced itching in the absence of whealing. Even in the presence of confluent whealing, the itching produced was never severe. In contrast, all the active endopeptidases invariably elicited the pure sensation of intense itching without any wheal or flare.

Study of our results leads us to postulate that the release of intracellular proteinases (cathepsins) from the epidermis or elsewhere plays a significant part in itching. High levels of proteinases or low levels of inhibitory factors[3] may explain itching in systemic disease or in various dermatoses.

It seems reasonable to assume that new loci of attacks have been disclosed for the pharmacologist seeking an effective antipruritic agent. Many of the quasi-effective therapies of to-day (for example, antihistaminics, sulphapyridine and arsenicals) could depend upon a partial inhibition of proteinases. The methods of enzymology may point the way to a truly specific means of temporarily blocking the proteases and therewith pruritus.

Robert P. Arthur
Walter B. Shelley

Department of Dermatology,
University of Pennsylvania,
Philadelphia, Pennsylvania.
Jan. 14.

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Amino-Acid Composition of Four Different Kinds of Human Hæmoglobin

The following hæmoglobins from human blood are known at present: normal adult (*A*), fœtal (*F*), sickle cell (*B*), and *C*, *D*, *E* and *G*. The most useful method of distinguishing between these hæmoglobins is based on their different electrophoretic mobilities, while some of them also have other characteristic properties such as high resistance to alkali (*F*) and low solubility (*B*). The amino-acid composition of the different hæmoglobins has been discussed in recent years; thus Schroeder *et al.*[1] found that the amino-acid composition of carboxyhæmoglobin-*A* and *B* was about the same, and van der Linden[2] described differences in the amino-acid composition of globins prepared from blood of normal adults and from cord blood[3].

The present work deals with the estimation of the amino-acid composition of four different hæmoglobins (*A*, *B*, *C* and *F*). These hæmoglobins were prepared from blood of normal adults (*A*), from cord blood after removing the adult component by treatment with alkali by Chernoff's method[4] (*F*), from the blood of patients with sickle cell anæmia (*B*) and from the blood of patients with the homozygous hæmoglobin-*C* disease (*C*). These four hæmoglobins were electrophoretically pure. Acid hydrolysates of these hæmoglobins, made by boiling under reflux 150 mgm. of carboxyhæmoglobin in 200 ml. of 6 *N* hydrochloric acid for 48 hr., were chromatographed on ion exchange columns as described by Stein and Moore[5].

Table 1. Amino-acid Composition of 48 hr. Hydrolysates of Four Different Kinds of Human Carboxyhæmoglobin (gm./100 gm. Protein)

Amino-acid	COHb-*A*	COHb-*F*	COHb-*B*	COHb-*C*
Aspartic	10·50	10·26	10·51	10·34
Threonine	5·49	6·51	5·86	5·59
Serine	4·46	5·83	4·56	4·35
Glutamic	7·25	7·65	7·16	7·21
Proline	4·96	4·22	4·64	5·06
Glycine	4·54	4·60	4·25	4·47
Alanine	9·96	9·68	9·87	9·81
Cystine/2	0·99	0·97	1·03	1·04
Valine	10·91	9·51	10·85	10·79
Methionine	1·40	1·84	1·23	1·36
*iso*Leucine	0·33	1·84	0·38	0·33
Leucine	15·16	15·29	15·06	14·81
Tyrosine	3·85	3·18	3·85	3·87
Phenylalanine	7·83	7·87	8·11	7·98
Lysine	9·89	9·86	9·70	10·86
Histidine	8·81	7·38	8·32	8·61
Arginine	3·36	3·34	3·33	3·41
Total*	109·19	109·83	108·71	109·89
Nitrogen recovered (per cent)*	91·8	91·4	90·2	93·1

* Without hæm, tryptophan and amide nitrogen.

The results of these amino-acid analyses are given as a mean of four determinations of the same number of separately prepared samples for each hæmoglobin (Table 1). During acid hydrolysis, however, some destruction of some of the amino-acids occurs[6]; for example, serine (about 17 per cent), tyrosine (about 12 per cent), threonine and methionine (about 11 per cent) and lysine (about 7 per cent). The values given in the table are not corrected for these losses.

On comparing the amino-acid composition of carboxyhæmoglobin-*A* and *F*, we find that there are differences in the percentages of many amino-acids. Threonine, serine, methionine, *iso*leucine and perhaps glutamic acid are present in higher concentrations in the fœtal hæmoglobin, whereas proline, valine, tyrosine, histidine and perhaps alanine are present in smaller amounts. One of the most striking differences in the amino-acid composition of hæmoglobin-*A* and *F* is the much higher content of *iso*leucine in the fœtal pigment. Calculated as number of residues per 68,000 mol. weight, carboxyhæmoglobin-*F* contains ten residues of *iso*leucine, whereas only two residues of this amino-acid are present in the adult component. The absence of significant differences between carboxyhæmoglobin-*A* and *B* described by Schroeder *et al.*[1] was confirmed, while the amino-acid content of carboxyhæmoglobin-*C* is only different for two basic amino-acids, namely, lysine and histidine, which were found to be higher in this protein.

Regarding a possible relation between the differences in amino-acid compositions of these hæmoglobins and their electrophoretic behaviour[7,8], it is surprising that only for hæmoglobin *C* does the more basic nature of this protein contribute to its greater electrophoretic mobility in phosphate buffer solution *p*H 6·75. For the other two hæmoglobins, *B* and *F*, which contain even fewer basic groups, the greater electrophoretic mobility may be explained by a different structure of the polypeptide chains in these proteins.

It is generally assumed that the hereditary factors which control the synthesis of the different hæmo-

globins *A*, *B*, *C*, *D*, *E* and *G* are multiple alleles, while for the synthesis of fœtal hæmoglobin the presence of a gene at another locus is likely. The differences in the amino-acid composition of the four hæmoglobins may perhaps support these hypotheses, as these differences between hæmoglobin-*A* and *F* are more numerous and much greater than those between hæmoglobin-*A* and *B* or *C*, the amino-acid compositions of which are, with the exception of a few basic amino-acids in *C*, about the same.

A detailed description of this work will be given elsewhere. We are indebted to Dr. A. van der Sar (Curaçao) for blood samples of patients with sickle cell anæmia and with the homozygous hæmoglobin-*C* disease, and to Dr. T. H. Scheinberg (New York) for a sample of pure hæmoglobin-*C*. This work was supported by a grant from the Netherlands Organization for Pure Research (Z.W.O.).

T. H. J. Huisman
J. H. P. Jonxis
P. C. van der Schaaf

Department of Pediatrics,
University of Groningen.
Jan. 19.

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Chromatographic Estimation of Different Kinds of Human Hæmoglobin

Ion-exchange resins, especially 'Amberlite *IRC*-50', have recently been used for the purification of proteins[1–5]; with the aid of this cation exchanger, two different hæmoglobins, fœtal sheep and bovine carboxyhæmoglobin, could be separated[6]. Extending these experiments to human hæmoglobin, we developed two methods for the separation and quantitative estimation of four different kinds of human hæmoglobin, namely, carboxyhæmoglobin-*A* (adult), *B* (sickle cell), *C* and *F* (fœtal).

In our first method (elution method), which is in general the same as described by Boardman and Partridge[6], the cation exchanger 'Amberlite *IRC*-50 (*XE*-64)', pretreated as described by Hirs *et al.*[3], was used. The best separation of the four different hæmoglobins investigated was obtained at *p*H 6·50 (citrate buffer with a constant amount of citric acid and different sodium ion concentrations). Under these experimental conditions, fœtal hæmoglobin is practically not absorbed. The separation of carboxyhæmoglobin-*F* and *A* is improved by a relatively low rate of flow of the effluent. Fig. 1 shows the chromatogram of the four different hæmoglobins using a column of 'Amberlite *IRC*-50 (*XE*-64)' of 13 cm. × 0·9 cm. at 10° C. The separation of the components of the hæmoglobin mixture is quite good. The yields were about 85 per cent at 10° C., but could be improved by working at lower temperatures.

The second method (cuvette method) is a simplification of the first. The 'column' used consists of a flat cuvette ('Lucite') of 3·0 cm. × 0·5 cm. × 20 cm., which is filled up to 15 cm. with 'Amberlite

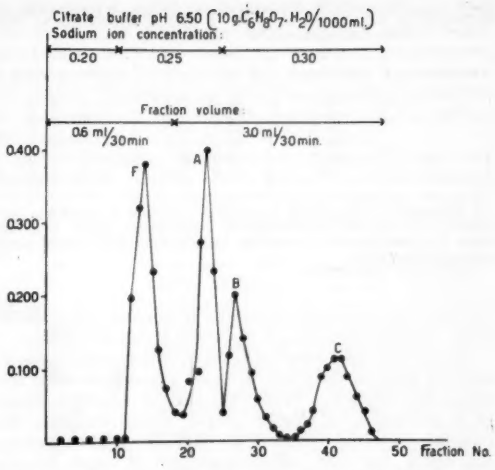

Fig. 1. Elution curves of four different kinds of human hæmoglobin, chromatographed on 'Amberlite *IRC*-50 (*XE*-64)'. 48·5 mgm. carboxyhæmoglobin (in 0·5 ml.) was chromatographed; from each fraction, after dilution to 4 ml., the extinction was measured at 5700 A. Temp., 10° C.; recovery 85 per cent. The carboxyhæmoglobins are indicated by *F* (fœtal); *A* (adult) *B* (sickle cell); and *C*

IRC-50 (*XE*-64)'. About 10–15 mgm. carboxyhæmoglobin (in 1·0 ml.) is chromatographed using a sodium citrate – citric acid buffer (sodium ion concentration 0·15) of *p*H about 6 at 0° C. After the elution of 200 ml. effluent, siphoned into the cuvette at a rate of about 20 ml. per hr., a good separation of the four components is obtained (Fig. 2). The mean rates of displacement are quite different for each component and are in the proportions of 1·33 (*F*) : 1·00 (*A*) : 0·72 (*B*) : 0·34 (*C*). The amounts of the hæmoglobins present in the mixture are estimated by measuring a diapositive of the cuvette according to the method of Grassmann and Hannig[7]. The

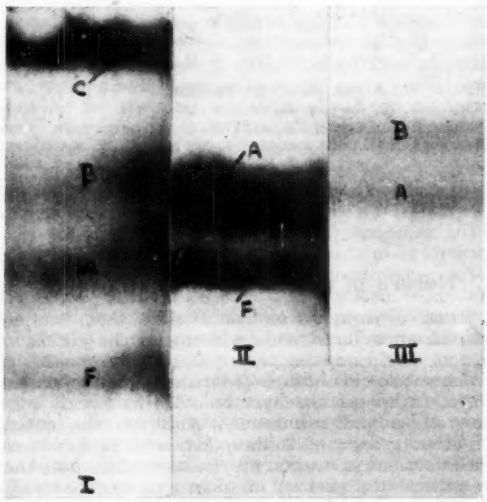

Fig. 2. Chromatographic separation of different hæmoglobins by the cuvette method. I: artificial mixture of four different hæmoglobins (200 ml. effluent was eluted); II: hæmoglobin of a patient with Cooley anæmia (100 ml. eluted); III: hæmoglobin of a patient with a sickle cell trait (100 ml. eluted)

Table 1. Percentage Estimation of Fœtal Hæmoglobin in Mixtures of Carboxyhæmoglobin *A* and *F* estimated by the Two Chromatographic Methods at 0° C.

Sample No.	Calculated	Elution method	Cuvette method
1	83·5*	85·5 ; 84·0†	91·5 ; 91·5
2	72·5	75·0 ; 73·0	79·0 ; 77·5
3	59·0	56·5 ; 61·5	61·0 ; 61·0
4	42·5	48·5 ; 43·5	49·5 ; 47·5
5	24·0	23·0 ; 29·5	22·0 ; 19·5
6	12·0	17·0 ; 12·5	12·5 ; 12·5

* Estimated by the alkali denaturation method of Brinkman and Jonxis (ref. 8); the percentages of carboxyhæmoglobin *F* in the other five samples were obtained by dilution with normal adult carboxyhæmoglobin.
† Duplicate estimations.

method can be carried out in a normal refrigerator with a larger number of cuvettes simultaneously.

As regards quantitative results, it is found (Table 1) that in general they are in good agreement with the calculated values. With the elution method, there is a deviation of about 2 per cent, whereas the cuvette method shows a slightly higher error, especially at low concentrations of one of the components.

The methods described here may be of value for the determination of relatively low percentages (less than 10 per cent) of fœtal hæmoglobin, as the separation of this pigment from the other hæmoglobins is good even at small concentrations. Moreover, the elution method has the advantage that an abnormal hæmoglobin can be eluted free of other pigments and used for further research.

A full account of this work will be given elsewhere. We wish to thank the Rohm and Haas Company (Philadelphia 5, Pennsylvania) for a gift of 'Amberlite *IRC*-50 (*XE*-64)'. The investigations were supported by a grant of the Nutricia Co., Zoetermeer, The Netherlands.

H. K. Prins
T. H. J. Huisman

Department of Pediatrics,
University of Groningen.
Jan. 19.

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Nature of the Cuticle of Pycnogonida

Recent work has tended to show that, in spite of differences in structural features, the cuticle of insects conforms to a basic pattern in consisting of an inner protein-chitin endocuticle and an outer non-chitinous lipoprotein layer bounded externally by a very thin lipid membrane[1]. Although the cuticle of other groups of Arthropoda are not known in such detail as in insects, previous work indicates that in general the pattern in them may not be unlike that in insects. However, in the mode of hardening of the cuticle marked differences have been noted. While in insects the hardening is by phenolic tanning, in crustaceans, though the cuticle is initially hardened to some extent by phenolic tanning, the prime cause of hardening is by calcification[2]. In arachnids such as *Limulus*[3] and *Palamneus*[4] there is evidence of the occurrence of hardening by sulphur linkages. Although the significance of such a mode of hardening in the above-mentioned types is not clear, it appears that it may be more common than has hitherto been suspected. It is therefore of interest to find in the cuticle of *Propallene kempi*, a common pycnogonid of Madras, evidence to suggest the occurrence of disulphide linkages which are probably involved in the hardening of the cuticle.

Transverse sections of the cuticle show an inner layer marked by horizontal lamellations and traversed by dermal gland ducts, and a very thin, apparently homogeneous, outer layer bounded by a very thin dark membrane. These two layers correspond to the epi- and endo-cuticle of insects. With Mallory's triple stain, the endocuticle turns a blue colour while the epicuticle is unstained. With Heidenhain's hæmatoxylin also the epicuticle did not take up the stain; but the endocuticle took up a faint brown coloration. From the chitosan and Schultze's tests it is inferred that the endocuticle contains chitin and the epicuticle is devoid of it. By prolonged treatment with chlorated nitric acid the epicuticle may be separated from the endocuticle, which does not survive the above treatment. Both the epicuticle and endocuticle are not positive to Millon's and the xanthoproteic tests, while only the outer dark membrane gives a positive reaction to the argentaffin test. This membrane is also positive to sudan black *B*. The chemical features indicated by the above tests strongly recall those of the epicuticle of *Palamneus*[4,5]. The similarity is further emphasized by the positive reaction to tests for organic sulphur. The unstained region of the epicuticle is reactive to the thioglycollate test, which is further confirmed by the positive reaction to alkaline lead acetate; this turns the uncoloured inner epicuticle to a deep brown or black. With alkaline sodium sulphide the cuticle undergoes marked softening, and sections of such material when stained with Mallory's triple stain show that the inner epicuticle, which in untreated sections is non-staining, now becomes reactive to stains. But unlike the epicuticle of other arthropods, which invariably stains red with acid fuchsin of the Mallory, the epicuticle of the pycnogonid takes up a blue colour like the endocuticle. The absence of a differential staining of the epi- and endo-cuticle in Mallory by which the two layers are usually distinguished in other arthropods is remarkable.

From the observations reported above, it may be inferred that the epicuticle is hardened by disulphide bonds as in *Palamneus swammerdami*, and treatment with alkaline sodium sulphide results in a breaking up of the bonds and the consequent resumption of the ability to take up stains, similar to the effect produced by diaphanol on cuticle hardened by phenolic tanning. A fuller account of this work will be published elsewhere.

G. Krishnan

Department of Zoology,
University of Madras.
Dec. 23.

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Meiosis in *Furcellaria fastigiata* (L.) Lamour.

THE tetrasporangium of *Furcellaria fastigiata* (L.) Lamour. remains uninucleate for five months or more before the tetraspores are formed. The meiotic divisions then take place rapidly throughout the numerous sporangia and have been observed at Aberystwyth between November 9 and 15.

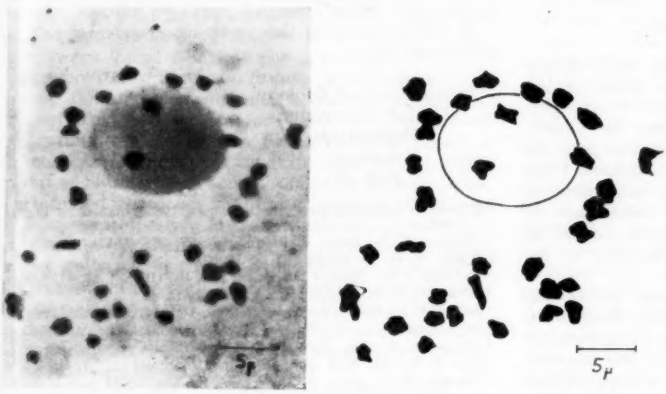

Fig. 1. Diakinesis in the tetrasporangium of *Furcellaria fastigiata* (L.) Lam. (*a*) Photomicrograph of nucleus. (*b*) Camera lucida drawing. The large 'bivalent' referred to in the text is towards the lower left of the figure

Owing to the inaccessibility of the plant on the seashore, except at low water of spring tides, the plants were kept in tanks in order to observe the nuclear divisions. They remained quite healthy in fresh aerated sea water when placed in subdued light. Nuclei in division were found most frequently between 9.00 p.m. and 12.00 midnight, corresponding approximately with high water in the neighbourhood.

The nuclei were observed by using a modification of the alum–acetocarmine squash technique[1] after fixation in acetic-alcohol or Carnoy's fluid (from unpublished information communicated by K. R. Lewis, Department of Botany, University College, Cardiff). Formalin – acetic - alcohol[2] also gave good results and enabled spindles to be more clearly seen.

Early prophase nuclei, before chromosome duality, clearly show distinct thread-like chromosomes independent of the nucleolus, which is single and persists until the end of diakinesis. Chromomeres are conspicuous on the uncontracted prophase chromosomes. Subsequent stages lead rapidly through pairing to early diplotene and then diakinesis, in both of which the haploid count appears to be $n = 34$, or possibly 35, doubt being centred about one bivalent of larger dimensions than the others. The diakinesis is prolonged; most of the chromosome pairs show two chiasmata, while possibly two pairs show one, and one or two show three. Fig. 1 shows a typical diakinesis in the tetrasporangial nucleus.

The distribution of the chromosome pairs in the nucleus changes markedly between diakinesis and metaphase proper, constituting a short prometaphase, during which the highly contracted bivalents shift from their peripheral diakinetic position to form a roughly equatorial cluster around degenerating nucleolar fragments in the centre of the nucleus. On the metaphase plate the bivalents are even more contracted, and two dense more-or-less ring-shaped bunches of small globular chromosomes separate at anaphase. The faint but definite spindle appears to be anastral and has its axis orientated obliquely to the longitudinal axis of the sporangium.

In the daughter nuclei reconstruction occurs, the chromosomes become de-spiralized and secondarily associated to some extent, nucleoli form, and an almost complete resting state is assumed. An incipient wall is initiated before early anaphase, and its formation —thought to involve a phragmoplast—is quite advanced before the second meiotic divisions occur. The latter are not as simple to observe, the chromosomes are smaller after splitting, and metaphase and anaphase often seem a little irregular. The secondary cross-walls, that is, the walls dividing the products of the second division into the four zonate spores, begin to form prior to this division. The spindles of the second division are arranged approximately with their axes along a pair of opposite edges of a tetrahedron.

A detailed account of this work will be published elsewhere.

A. P. AUSTIN

University College of Wales,
Aberystwyth.
Jan. 20.

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Golgi Bodies in the Spermatogenesis of Pulmonate Gastropods

Nath and Chopra have recently completed investigations on the spermatogenesis of the Simla slug, *Anadenus altivagus* (Theobald). This material has unexpectedly turned out to be an excellent material for the demonstration of (1) the origin of Golgi dictyosomes from the mitochondrial granules by alignment, and (2) the secretion of the acrosome by the dictyosomes. These workers have also examined the living material under the phase-contrast microscope.

In the earliest spermatogonia of *Anadenus* there is no indication of any granulation, the cytoplasm staining uniformly with iron-hæmatoxylin after Flemming - without - acetic acid fixation. In late spermatogonia the mitochondria appear for the first time in the form of granules; but there is no indication whatsoever of the Golgi dictyosomes. It is in the earliest primary spermatocytes that the mitochondria begin to align themselves to form the Golgi dictyosomes. To begin with, the dictyosomes have a crenated appearance, but soon they acquire a uniform contour. Nor is there any chromophobic vesicle attached to a dictyosome. In the fully grown primary spermatocyte the dictyosomes all collect together, and there is only one such collection to each cell.

During metaphase I, however, when the spindle, the centrioles, the chromosomes and the mito-

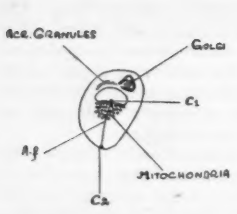

Fig. 1

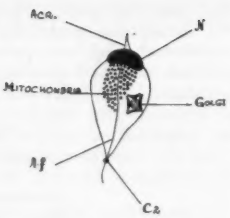

Fig. 2

chondrial granules are all brought up very clearly in the finished sections, there is no trace of the dictyosomes left. Just previous to this, in the preceding diakinesis, the dictyosomes can be clearly seen breaking up into granules, which merge into the mitochondrial granules. During late telophase I the dictyosomes are again formed by the alignment of mitochondrial granules; and during metaphase II and anaphase II, the dictyosomes again break up to merge into the mitochondrial granules, to reappear again during late telophase II.

In the course of spermateleosis and before the deposition of the acrosome, each Golgi dictyosome develops in close association with it a chromophobic vesicle. The Golgi apparatus shifts to the anterior aspect of the spermatid nucleus; and a large number of minute acrosomal granules, first seen in the chromophobic vesicles, are deposited in front of the nucleus. These granules afterwards form the acrosome, and the Golgi apparatus, having performed its function of secreting the acrosome, is sloughed off (Figs. 1 and 2).

Hirsch[1] derives the Golgi pre-substance, that is, the Golgi granules, from the mitochondria. In my view, stronger evidence than *Anadenus* in favour of Hirsch's view could not be wished for, as the Golgi dictyosomes in this material not only arise from the mitochondria but also merge into them during metaphase I and II. This material also provides strong support for the view of Hirsch that the secretion or the product arises in the internum of the Golgi complex. In support of the contention that the Golgi dictyosomes in *Anadenus* originate from the mitochondrial granules, so that to begin with the dictyosomes have a crenated appearance, reference may be made to Gatenby, ref. 2 (Fig. 24, Pl. 32) and to Watts, ref. 3 (text-figs. 4 and 5), in which the dictyosomes with a jagged contour have been figured.

All previous workers on the male germ-cells of pulmonate gastropods, with one exception, describe the Golgi element as a dictyosome. Gatenby[2,4] on *Helix aspersa* and some other pulmonates and *Limnaea*, Hickman[5] on *Succunia ovalis*, Baker[6] on *Helix aspersa*, and Watts[3] on *Arion subfuscus* have all described the Golgi body as a dictyosome or a banana-shaped rod associated with which is a chromophobic sphere. Again, earlier workers who studied the formation of the acrosome state that this structure is secreted by the Golgi apparatus. After secreting the acrosome, the Golgi apparatus is said to be sloughed off according to all previous accounts. But Srivastava[7], working on *Vaginula maculata*, has described the Golgi apparatus in the male germ-cells of pulmonate gastropods as a single spherical body and not as a collection of dictyosomes; he is the only worker who has stated that "there is no connection between the Golgi body and acrosome".

It is suggested that Srivastava's Golgi body is in reality an enigmatic chromatoid body corresponding to such a body in the spermatogenesis of the domestic duck[8] and the chequered water snake, *Natrix p. piscator*[9]. The histochemical reactions of the chromatoid bodies of the duck and the snake are exactly similar to those of the Golgi body, as described by Srivastava in *Vaginula*. Sud and Gupta have applied the specific lipoid stain recommended by Baker[6] and Thomas[10], namely, sudan black, on these chromatoid bodies and have obtained negative results.

A full account of the work on *Anadenus* will be published later.

Vishwa Nath

Department of Zoology,
Panjab University,
Hoshiarpur,
Panjab.
Feb. 28.

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Failure of Myxomatosis on Skokholm Island

Attempts to exterminate the wild rabbits on the Pembrokeshire island of Skokholm by various methods were described in *Nature*[1] in 1940. The late Sir Charles Martin brought the virulent strain *B* of the virus known as *Myxomatosis cuniculi* Sanarelli 1898 to the island in three separate attempts to induce myxomatosis in rabbits in 1936, 1937 and 1938. In each attempt the marked rabbits (inoculated with the virus) appeared to have died within the usual period of less than fourteen days; but there was little or no spread to uninoculated rabbits. At the time, the apparent failure of this virus to spread in the dense colony of rabbits on Skokholm seemed inexplicable, since the same strain had wiped out rabbits in Sir Charles Martin's enclosures (500 sq. yd.) at Cambridge in 1934–35[2]. It is significant that before conducting these controlled experiments in the field in Cambridgeshire, Sir Charles had evidently decided that the possibility of the virus being carried to wild rabbits elsewhere by insects was too remote to constitute a public danger—a risk that would not be lightly undertaken by scientists to-day. Sir Charles believed that the disease was chiefly propagated by direct contact. We now know that contact alone is not effective, and the virus must enter the tissue of a healthy rabbit through a scratch, cut or insect bite.

The absence of fleas on the island rabbits was noticed in 1936–38; but its significance was overlooked. Sir Charles had relied upon the statement by Aragão in Brazil that the cat flea, *Ctenopsylla felis*, infesting rabbits was capable of transmitting the virus; but in view of the small number of cases in which positive results were obtained, Aragão believed that this mode of transmission was exceptional.

As the role of the European rabbit's natural flea, *Spilopsyllus cuniculi*, as chief vector of the myxoma

virus in Britain has now been established[3], it seemed desirable to investigate the degree of infestation by this flea of the rabbits on Skokholm, which still continue to remain unaffected by the present epidemic of myxomatosis. In the summer of 1954 the warden of Skokholm Bird Observatory examined for me thirty rabbits taken there; but could find only one flea—this was not identified and may have been a bird flea (numerous puffins and shearwaters nest in rabbit burrows on Skokholm). In March 1955 I visited Skokholm and examined a further thirty rabbits, as soon as taken alive, without finding a single flea. (Mainland rabbits show an infestation of between 0 and 270 fleas per individual.)

It seems clear that the failure of myxomatosis to spread at Skokholm was, and is, due to this absence of the virus-carrying *Spilopsyllus* flea. The absence or scarcity of this flea on Skokholm (240 acres) is in contrast with conditions on the neighbouring island of Skomer (750 acres), where on May 25, 1954, I examined three adult rabbits carrying 3, 12 and 12 fleas respectively. Myxomatosis arrived naturally on Skomer (probably via fleas carried on carrion-eating gulls which were feeding on rabbits dying of the disease on the mainland, and which were roosting the same night on Skomer—as these gulls also roost at Skokholm) in the autumn of 1954, and has since almost completely destroyed the Skomer population of at least six thousand rabbits.

As a vector, the European rabbit flea seems to be more effective in temperate climates than the various species of mosquitoes, which spread the virus in warm humid regions or weather. In Australia the European rabbit flea is unknown, and the native stickfast flea, *Echidnophaga* (from marsupials), which attaches itself to rabbits, is a much less effective vector, often perhaps in chain-transmission with the mosquito. In New Zealand, where there are no rabbit or marsupial fleas[4], introductions of the myxoma virus have generally failed in spite of numerous indigenous biting mosquitoes and sandflies[5].

R. M. Lockley

The Nature Conservancy,
19 Belgrave Square,
London, S.W.1.

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Effect of 'Tobacco Leaf-Curl' and Tobacco Mosaic Virus on the Amino-acid and Amide Content of *Nicotiana* sp.

The results of Martin, Balls and McKinney[1], Meneghini and Delwiche[2], Commoner *et al.*[3] and others have shown that virus synthesis is associated with a remarkable increase in the soluble protein content of *Nicotiana* leaves infected with tobacco mosaic virus. Takahashi and Mamoru[4], and Commoner *et al.*[5], have resolved and isolated a new protein from virus-free extracts of mosaic tobacco leaves, which was not detected by Wildman, Cheo and Bonner[6], by electrophoresis. A study of free and hydrolysed protein of both healthy and virus-infected leaves, by a modified technique of horizontal paper chromatography, has revealed the absence of a ninhydrin-reacting substance (present in healthy leaves) from the water extract of leaves infected with tobacco mosaic virus and leaves infected with tobacco curl virus. Further, the water-soluble extracts of diseased leaves revealed the presence of two new bands corresponding to asparagine and histidine–lysine.

The leaves were extracted with hot water, and the hydrolysate prepared by hydrolysing the residue of the plant material with 6 *N* hydrochloric acid and autoclaving at 15 lb. pressure for 2 hr. The solutions were centrifuged at 2,000 revolutions per minute and the clear supernatant liquid was spotted on their respective places for the separation and identification of the amino-acids.

To eliminate any overlapping of the adjacent bands[7], thus making quantitative estimations[8] more reliable, and also to keep a number of solutions on the same paper[9], a modification made by Ranjan *et al.*[10] proved to be the most successful one. Whatman filter paper No. 1 of 40 cm. diameter having sixteen equal sectors separated by sixteen radial cuts was used in the present investigation. Reference solutions were placed at four different points to facilitate identification of the bands. The method used incorporates the advantages of both circular paper chromatography and strip-paper chromatography. A single sector may be compared to a strip; radial flow of the solvent is maintained and the amino-acids appear in arcs instead of spots.

The chromatogram was run with butanol/acetic acid/water (4 : 1 : 5) for 8 hr. using a single paper wick (2 cm. × 4 cm.) in the centre. The solvent front was marked, the paper dried at room temperature (24° ± 1° C.) and sprayed with 0·1 per cent ninhydrin in acetone. Bands were allowed to develop for 4 hr. at room temperature and then at 70° C. for 10 min.

The acid hydrolysate of both healthy and diseased leaves revealed the same range of amino-acids: leucine and *iso*leucine (R_F 0·83), phenylalanine (0·76), valine and methionine (0·69), tyrosine (0·62), alanine (0·50), glutamic acid and threonine (0·44), glycine and aspartic acid (0·34), arginine (0·24), and histidine and lysine (0·20). Tryptophan could not be detected as it is destroyed by hydrochloric acid.

In the case of the water-soluble or free amino-acids, it was observed that the concentration of the amino-acids, and specially of aspartic acid, showed a marked increase in the case of the virus-infected leaves, as judged by the deepness of the bands. In addition, two new bands were present in the water-soluble extracts of the diseased leaves, one corresponding to histidine–lysine (0·20) and the other to asparagine (0·28). The lowest band (R_F 0·065) present in the water-soluble extract of healthy leaves, which could not be identified, was absent in that from the diseased leaves. The other common free amino-acids present in the water-extracts of both healthy and diseased leaves are: tyrosine (0·62), proline (0·54), alanine (0·50), glutamic acid (0·44), aspartic acid (0·34) and serine (0·32).

The absence of threonine and glycine was established by using buffered paper and by running the chromatogram in butanol/acetic acid mixture buffered to *p*H 12.

The absence of the lowest unidentified band from the water-soluble amino-acids of diseased leaves suggests that it is used up in the synthesis of the virus itself, or the virus interferes in its synthesis in the host.

Knight[11] has reported the presence of lysine with other amino-acids in the nitrogen content of tobacco mosaic virus. It is possible that the new band having R_F value 0·20 might be the lysine of tobacco mosaic virus protein. However, the formation of asparagine and the increase in the content of other free amino-acids, specially aspartic acid, in the diseased leaves supports Bawden's view[12] that virus infection leads to the formation of a new range of proteins.

We are grateful to Prof. Shri Ranjan for his suggestions and for laboratory facilities. We thank also Sri K. S. Bilgrami for his help in autoclaving the solutions.

M. M. Laloraya
Govind Jee

Department of Botany,
University of Allahabad.

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Extreme Resolution of Infra-Red Absorption Spectra

Rank and Wiggins have constructed an infra-red spectrometer with a plane grating of fine quality and 10-metre optics, double-passed[1].

An ideal subject with which to study the resolution was found in the *l*-doublets of the $\pi \rightarrow \pi$ band of hydrogen cyanide at 1·5μ. The components of these doublets are equal in intensity and their separations are proportional to the J numbers[2]. Moreover, the separations are known, so that a distinction can be made between the conditions 'just resolved' and 'fully resolved'. When a doublet is 'just resolved', the structure is recognized but the apparent separation between the components is smaller than the true value. For example, $P(7)$ was just resolved with a measured separation of 0·072 cm.$^{-1}$ as compared with the actual value of 0·096 cm.$^{-1}$. The closest doublets to be fully resolved were $P(15)$ and $R(9)$, the true separations of which are 0·180 cm.$^{-1}$ and 0·173 cm.$^{-1}$ respectively.

While this performance exceeded that of any other existing grating instrument, it was deemed of interest to investigate the possibility of increasing the resolution even further. Since the limit of resolution was set, not by lack of energy or by insufficient sensitivity of the detectors but by imperfections in the grating itself, nothing was to be gained by additional passes through the optical system. Indeed, since it was unlikely that gratings of substantially better quality would be produced in the near future, it was clear that improvement could not be obtained with any grating instrument alone, no matter what its design.

A method for using a Fabry–Perot interferometer in infra-red absorption studies has already been described[3]. The technique had been developed originally to improve the resolution of small spectrometers; but it was superseded by the device of multiple-passing[4]. It was found to be tedious and impractical by comparison. However, the interferometer is very suitable for our present purpose.

A Fabry–Perot interferometer was crossed with the grating spectrometer. The separation of the interferometer plates was set so that the range of frequency between orders was equal to the spectral slit-width of the spectrometer, which thus served as a primary monochromator the function of which was to remove overlapping orders. If a fraction Δm of a fringe order could be resolved, then under the above conditions the resolution of the combination of the interferometer and spectrometer was as much as $1/\Delta m$ times that of the latter alone. In this way it was possible to resolve fully the doublets $P(3)$ and $R(2)$; the measured separation of $R(2)$ was 0·045 cm.$^{-1}$. This is seen to represent a sixfold improvement if the Doppler width (0·016 cm.$^{-1}$) of the lines is taken into account.

The effective reflectivity of the plates was 65 per cent, produced by zinc sulphide – magnesium fluoride coatings. The plate separation was 28·5 mm.

The purpose of this communication is to direct attention to the fact that it is now possible to attain a full resolving power of well in excess of 200,000 at 1·5μ. This may be near the useful limit at the present time, because of Doppler broadening of the absorption lines. Nevertheless, the system has still not reached its energy limit, and the resolution could be improved further by increasing the separation between the plates of the interferometer. Full details of the instrument will be published elsewhere.

This research was assisted by support from Contract *N6onr* Task V of the U.S. Office of Naval Research.

J. H. Jaffe*
T. A. Wiggins
D. H. Rank

Physics Department,
Pennsylvania State University,
State College, Pennsylvania.
Jan. 5.

* On sabbatical leave from the Weizmann Institute of Science, Rehovoth, Israel.
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A Solar Noise Outburst of January 15, 1955

An interferometer-type noise receiver has been operating at the Radio Physics Laboratory of the Research Defence Board, Canada, for more than a year. This receiver has been recording the radiation at a frequency of 50 Mc./s. from the discrete source in the constellation of Cassiopeia. However, the antenna is so constructed that solar noise will be recorded if of sufficient magnitude.

On January 15 of this year a particularly large noise outburst from the sun was observed. The outburst commenced at 9.45 a.m. Eastern Standard Time as a single spike on our record, which lasted approximately four minutes. This was followed at 9.53 a.m. by a large increase in the noise-level lasting until 3.00 p.m. On the following day a very large burst was again observed, commencing at

4.10 p.m. and continuing until 4.30 p.m. On January 17 no outstanding events were observed on our records, but on January 18 a large burst was recorded during 3.57–4.10 p.m. The January 19 records also showed a large outburst during 8.36–9.30 a.m. In all cases the magnitude was not determined as the recording meter was driven off scale.

A study of the vertical-incidence ionospheric recorder records for Ottawa for the corresponding days indicated that an intense ionospheric storm followed the noise outbursts. The storm started about 9.00 a.m. on January 17 with spread echoes from the *F*2 region and absorption conditions, followed by a sequence of low *F*2 critical frequencies, blackout and sporadic *E* conditions. During the afternoon of that day, the ionosphere returned to near normal conditions, but during the evening very disturbed conditions were again observed. A succession of spread *F*2 echoes, lower *F*2 critical frequencies, increased absorption and sporadic *E* echoes from lower heights was observed, followed by a blackout. This storm continued through the night, and with the return of daylight a tendency towards normal was observed. By early afternoon of January 18, the ionospheric records indicated normal conditions for that time of year. On the evening of January 18 there was another ionospheric storm, but not so intense as that of the previous night. The disturbed conditions persisted into the following day, and a more severe ionospheric storm was recorded during the evening and night of January 19 than that observed on January 17. Normal conditions returned during the morning hours of January 20.

During the evening and night of January 17 a very intense auroral display was observed at several points in Canada and the United States. Observers in Churchill, Manitoba, reported a type *A* red aurora on that occasion. Intense auroral displays were also observed on the nights of January 18 and January 19.

This work was carried out under the Defence Research Board project *PCC-D*48-28-01-02.

T. R. Hartz

Radio Physics Laboratory,
Defence Research Board,
Shirley Bay,
Ottawa.
Feb. 8.

Low-voltage, Short-duration Arcs between Separating Contacts in Low-voltage, substantially Non-inductive Circuits

It was originally supposed that separating contacts in low-voltage, low-inductance circuits interrupted the current without arcing provided the supply voltage was lower than the ionization potential of the contact metal, and that the circuit inductance was not greater than about a microhenry. However, inconsistencies in the values of the measured 'fine transfer' obtained under these so-called arc-free conditions led to the supposition that arcs might be present[1], and this was confirmed by Lander[2], who published an oscillographic record of an arc obtained between separating gold contacts in a 6-volt, 1 microhenry circuit carrying a current of 1 ampere.

The existence of low-voltage 'short arcs' during contact closure has also been deduced from transfer and voltage measurements[3], and oscillographic records of these arcs have been published[4].

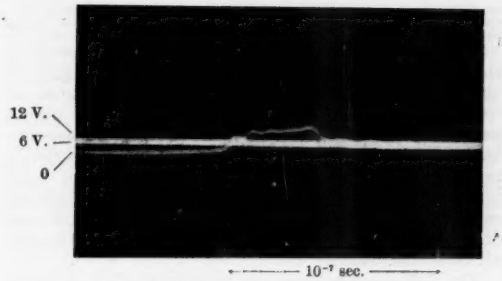

Fig. 1. Arc voltage record of separation of platinum contacts. Inductance, 0·09 μH.; break current, 3·3 amp.; supply voltage, 6 V.

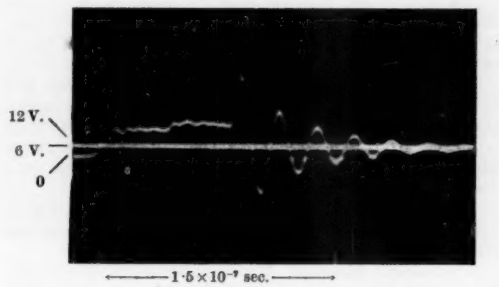

Fig. 2. Arc voltage record of separation of platinum contacts. Inductance, 0·34 μH.; break current, 3·3 amp.; supply voltage, 6 V.

Investigations carried out by the Electrical Research Association[5] on platinum contacts breaking a 6-volt circuit have shown that the amount of metal transfer is very dependent on the effective circuit inductance L and the current I at break for inductances between 0·06 and 117 microhenrys and currents between 1·3 and 5·6 amperes. These have led to the theory that the transfer is at least partly due to a form of 'short arc' in metal vapour between the contacts. The amount of transfer depends on the metal vapour and the available energy, $\frac{1}{2} LI^2$.

It has been possible to obtain single-sweep records of the voltage across the contacts immediately after break with the E.R.A. ultra-high-speed oscillograph and so to confirm the existence of the short arcs. Two of the records are shown in Figs. 1 and 2. It is seen that low-voltage arcs of very short duration exist even when the circuit inductance is as small as 0·09 microhenry. An attempt is being made to relate them to the measurements on the transfer.

Acknowledgments are due to the Director of the Electrical Research Association for permission to publish this communication.

Janet Riddlestone

Electrical Research Association,
5 Wadsworth Road,
Perivale, Middlesex.
Jan. 13.

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The New British Museum Law

The new British Museum Bill which passed its third reading in the House of Lords on April 27 has become law. It is of profound importance to all research scientists in biology and geology; but it had a meteoric flight through the House of Commons and the House of Lords. Its transit was apparently unheralded in the Press: its purport is of such national importance that it is surprising that no reference to the course it took through the Houses of Commons and Lords was available to biologists all over the world.

The Bill's second reading (*Hansard*, April 4, 1955, cols. 943–59) was proposed by the Financial Secretary to the Treasury (Henry Brooke), saying, "Its main purpose is to render it possible for objects in the Collection of the Natural History Museum to be lent abroad for research purposes". He was strongly supported by a Trustee, Mr. Chuter Ede, who spoke of the need to reciprocate in the loan of insects, etc., with foreign museums which lend to us. He was followed by five speakers, all congratulatory about the Bill, but not one of them made any reference whatever to type specimens, or showed that they knew of the danger to types in the Bill they were so complacently voting for.

The Bill was exceedingly short (one page) and its main purport was to allow the loan of specimens, which always hitherto has been prohibited.

On reading *Hansard*, I was alarmed by the threat to type specimens in this Bill. I ascertained that important officials of the Natural History Museum were also alarmed. Communications with Mr. Chuter Ede effected nothing. The Bill was passed with no alteration on April 6 (*Hansard*, col. 1,305) when Mr. Ede expressed "very sincere thanks for the expedition with which the Bill has been considered".

The *Manchester Guardian* published a letter from me on April 19. In it I wrote: "I am horrified by the way the bill has been so rushed . . . All it needs, however, is the addition of one short clause making it clear that type specimens are reserved and are never to be lent", and I made an appeal to the Lords to save the situation.

In the House of Lords the Bill was introduced by the Lord Chancellor, read a second time, and it was then anticipated that it would go through automatically. Fortunately, Lord Chorley, alive to the danger to type specimens, proposed an amendment that they should be reserved and never lent from the British Museum. This postponed consideration for a week. Meanwhile, Sir Guy Marshall, an entomologist, wrote to the *Manchester Guardian* (April 23) favouring the idea that type specimens of insects should be loanable. The *Manchester Guardian* published my reply (April 27), in the course of which I wrote: "The Lord Chancellor, proposing the bill, referred to my letter in your issue of April 19 and gave a solemn assurance that type specimens would be carefully protected by museum regulations. But surely it is bad law-making to pass a law that at once requires regulations to counter its purport. The British Museum should be adamant in retaining its proud position as being the only place in the world where every expert can be sure of finding types on the premises were he to arrive suddenly by air with only a few hours to do the comparative work he required. Under the projected bill he might arrive counting on this and find the essential type thousands of miles away. This is deplorable".

The same day the Bill was in the House of Lords Committee stage to consider Lord Chorley's amendment, Lord Chorley moved after "Provided that", to insert: "(*a*) the said power shall not extend to the lending of type specimens; and (*b*)" (*Hansard* for the Lords, April 27, cols. 599–603). Lord Chorley said, "your Lordships will appreciate that the type specimen, which is the very fountain of the work of research in its line, is of great importance. . . . It is true that the noble and learned Viscount went some distance in his speech on Second Reading to meet this point when he promised that the Trustees would make regulations under which type specimens would only occasionally be lent out, and I and those for whom I speak are grateful for his promise in that regard. But I suggest that it is not altogether satisfactory to be content with promises of that kind".

The Lord Chancellor (Viscount Kilmuir) said he hoped the amendment would not be pressed; but he promised that, "the Trustees of the British Museum, of whom I have the honour to be one, will regard this matter most scrupulously and will use this power in respect of type specimens only in the most unusual cases".

He was followed by the Earl of Ilchester, "the Trustees, of whom I am one, feel strongly on this point. . . . I wonder whether they will ever go out . . . every care will be taken to ensure that no specimen that should not go out is allowed to go".

Lord Strabolgi, supporting Lord Chorley, asked for a time-limit for loans.

He was at once answered by the Lord Chancellor, who said, "I will look into this point with pleasure".

Lord Chorley then withdrew his amendment, and said, "So long as these points are within the vivid recollection of the Trustees, I am sure they will see to it that they are properly attended to".

In the course of the hurried passage of the Bill the efforts to deal with such an important matter could not be mobilized. The keepers in the Natural History Museum, who are the chief experts, each responsible for the specimens dealing with his own science, whose opinions in this matter are of prime importance, were unrepresented. I asked at least one of the keepers to come to the House of Lords before the hearing so that one or two of the Lords might be informed by expert opinion, but as British Museum officials are Civil servants it was out of the question that any of the real experts could take any part in the 'back-stage' discussion which could only be conducted with the Director of the Natural History Museum, who was out of the country.

However, the consideration shown by the House of Lords and the promises made in response to Lord Chorley's efforts are reassuring, although the types are no longer protected by law as heretofore.

But it is evident scientists should always be on the alert, and it is to be hoped that in future more time will be given to any legislation affecting scientific matters of importance.

The quotations I have made are brief, and everyone interested in the Natural History Museum should read the verbatim reports in *Hansard*: Commons, April 4 and 6; Lords, April 21 and 27.

Marie C. Stopes

Norbury Park,
Dorking,
Surrey.
May 3.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, May 23

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. S. F. Nadel: "Magic Thinking".

Tuesday, May 24

SOCIETY FOR ENDOCRINOLOGY (at the Royal Society of Medicine, Wimpole Street, London, W.1), at 5 p.m.—Dr. A. Lacassagne (Paris): "Endocrine Factors Concerned in the Genesis of Experimental Mammary Carcinoma".*

WRIGHT-FLEMING INSTITUTE OF MICROBIOLOGY (at St. Mary's Hospital Medical School, London, W.2), at 5 p.m.—Prof. Lord Stamp: "The Action of Bacterial Enzymes on Immunizing Antigens" (Almroth Wright Lecture).

INSTITUTION OF CHEMICAL ENGINEERS (at the Royal Institution, 21 Albemarle Street, London, W.1), at 5.30 p.m.—Prof. Warren K. Lewis: "Mechanism of Fluidization of Powders in Gases".

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Sir John Cockcroft, F.R.S.: "Nuclear Power and World Energy Resources" (James Forrest Lecture).

UNIVERSITY OF LONDON (at the Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 5.30 p.m.—Prof. R. M. Barrer: "Some Tasks and Perspectives in Physical Chemistry"* (Inaugural Lecture).

Tuesday, May 24—Friday, May 27

INSTITUTION OF GAS ENGINEERS (at Portsmouth and Southsea)—92nd Annual General Meeting.

Wednesday, May 25

POLAROGRAPHIC SOCIETY (in the Chemistry Department, The University, Leeds), at 10 a.m.—Symposium on "Polarographic Instrumentation—Design and Application".

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Mr. Alan A. Burrows: "Use and Abuse of Sound".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. H. H. Read, F.R.S., and Prof. O. C. Farquhar: "The Buchan Anticline of the Banff Nappe of Dalradian Rocks in North-East Scotland"; Dr. J. Sutton and Dr. J. Watson: "The Boyndie Syncline of the Dalradian of the Banffshire Coast".

ROYAL SOCIETY OF MEDICINE, COMPARATIVE MEDICINE SECTION (at 1 Wimpole Street, London, W.1), at 5 p.m.—Annual General Meeting, followed by Symposium on "Factors Influencing Host-parasitic Relationships". Speakers: Dr. E. L. Taylor, Prof. A. A. Miles and Mr. F. C. Bawden.

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Dr. J. O. Irwin: "A Unified Derivation of Some Frequency Distributions of Importance in Biometry and Statistics".

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. J. A. H. Waterhouse: "Twins and Genetics".*

Thursday, May 26

INSTITUTION OF MINING AND METALLURGY (in the Apartments of the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 4 p.m.—Annual General Meeting. 5.15 p.m.—Mr. Stanley Robson—Presidential Address.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SENIOR LECTURER (university graduate with appropriate teaching and industrial experience) IN PHYSICS—The Principal, Enfield Technical College, Queensway, Enfield, Middlesex (May 26).

LECTURER IN MATHEMATICAL STATISTICS, a LECTURER IN BIOCHEMISTRY, a LECTURER or ASSISTANT LECTURER IN PSYCHOLOGY, an ASSISTANT LECTURER IN PURE MATHEMATICS, an ASSISTANT LECTURER or RESEARCH ASSISTANT IN VIRUS DISEASES and a RESEARCH FELLOW IN ASTRONOMY or ASTROPHYSICS—The Secretary, University College, Exeter (May 27).

ASSISTANT EXPERIMENTAL OFFICER IN THE GENETICS DEPARTMENT, to be responsible for the maintenance of genetic stocks and to assist the Head of the Department—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford (May 28).

EXTENSION LECTURER (with academic qualifications in pure science, preferably in physics or chemistry) IN SCIENCE in the Department of Extra-Mural Studies—The Director of Extra-Mural Studies, (King's College), Joseph Cowan House, 153 Barras Bridge, Newcastle-upon-Tyne (May 28).

LECTURER IN MATHEMATICAL PHYSICS—The Registrar, The University, Edgbaston, Birmingham 15 (May 28).

LECTURER (with an honours degree in electrical engineering or equivalent, and practical experience in either the heavy power side of electrical engineering or the light current side) IN THE DEPARTMENT OF ELECTRICAL ENGINEERING—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (May 28).

SENIOR LECTURER (with special qualifications in organic chemistry) IN THE DEPARTMENT OF CHEMISTRY—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (May 28).

VIROLOGIST, Scientific Officer grade (with a first- or second-class honours degree in botany) IN THE DEPARTMENT OF AGRICULTURE FOR SCOTLAND, Plant Pathology Station, East Craigs, Corstorphine, Edinburgh, to assist in field, laboratory and glasshouse research and routine work concerning potato diseases generally, and with particular stress on virus diseases and those affecting the quality of potato tubers—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting G.89/5A (May 30).

LECTURER IN PHYSICS—The Secretary of University Court, The University, Glasgow (May 31).

LECTURER IN PHYSIOLOGY, and an ASSISTANT IN PHYSIOLOGY—The Secretary of University Court, The University, Glasgow (May 31).

LECTURER or SENIOR LECTURER IN CHEMISTRY at Rhodes University, Grahamstown, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, May 31).

LIBRARIAN (preferably male, with a degree in natural or agricultural science), and a JUNIOR LIBRARY ASSISTANT (female)—The Secretary, Grassland Research Institute, Hurley, near Maidenhead (May 31).

SCIENTIFIC OFFICER (with a good honours degree in biological sciences and postgraduate experience in cytology) to undertake research on problems related to plant breeding—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford (May 31).

ASSISTANT LECTURER (with special qualifications in plant physiology) IN BOTANY, and an ASSISTANT LECTURER IN ANIMAL GENETICS—The Secretary and Registrar, University College of North Wales, Bangor (June 1).

LECTURER (with a good honours degree) IN BOTANY or ZOOLOGY, at the Nigerian College of Arts, Science and Technology—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (June 1).

RESEARCH FELLOW IN THE DEPARTMENT OF MATHEMATICAL PHYSICS—The Registrar, The University, Birmingham 15 (June 4).

ASSISTANT LECTURER IN PSYCHOLOGY—The Registrar, The University, Sheffield (June 7).

UNIVERSITY DEMONSTRATOR (with an honours degree in pure science with organic chemistry and biochemistry as the principal subjects, and preferably with farming experience) IN ANIMAL NUTRITION—The Secretary, School of Agriculture, The University, Cambridge (June 8).

LECTURERS IN BACTERIOLOGY, BIOCHEMISTRY, ANIMAL HUSBANDRY and CROP PRODUCTION at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (June 10).

PHYSICAL CHEMIST, Senior Research Officer or Research Officer grade (with a university honours or higher degree in science with physical chemistry as the major subject or equivalent qualifications, and preferably with research experience in surface chemistry), IN THE DIVISION OF PLANT INDUSTRY, Commonwealth Scientific and Industrial Research Organization, Canberra, A.C.T., Australia, to work on physicochemical problems arising from the investigation of the Division, initially on the action of herbicides at cell surfaces and intersurfaces, and on their movement within plants—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 130/202 (June 11).

PLANT PATHOLOGIST, Research Officer or Senior Research Officer grade (with an honours or higher degree in science, agricultural science or equivalent qualifications, and with research experience in plant pathology or mycology), IN THE DIVISION OF PLANT INDUSTRY, Commonwealth Scientific and Industrial Research Organization, Canberra, A.C.T., to undertake plant disease investigations and in particular to study fundamental aspects of host-pathogen relationships and mechanisms of resistance to disease—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 130/241 (June 11).

SENIOR LECTURER IN PHYSICS—The Registrar, The University Sheffield (June 11).

LECTURER or ASSISTANT LECTURER IN BIOCHEMISTRY—The Registrar, The University, Leeds 2 (June 13).

ROBERT RANKIN CHAIR OF ELECTRONIC ENGINEERING—The Registrar, The University, Liverpool (June 13).

ASSISTANT LECTURER IN MATHEMATICS—The Registrar, University College of North Staffordshire, Keele, Staffs (June 15).

CHAIR OF PHILOSOPHY at Auckland University College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand June 15).

SOIL CONSERVATORS (2) (preferably with experience in soil conservation practices) with the Otago Catchment Board, New Zealand—The Agricultural Liaison Officer, New Zealand House, 415 Strand, London, W.C.2 (New Zealand, June 15).

LECTURER IN GEOLOGY, with special reference to Palæontology—The Secretary, Birkbeck College, Malet Street, London, W.C.1 (June 18).

ASSISTANT LECTURER IN APPLIED MATHEMATICS—The Registrar, The University, Leeds (June 20).

DEMONSTRATOR (preferably with an interest in soil science) IN GEOLOGY—The Registrar, Wye College, near Ashford, Kent (June 25).

GEOMORPHOLOGIST, Research Officer grade (with a university honours degree with a strong geological background, and preferably with special training and subsequent experience in geomorphology), IN THE LAND RESEARCH AND REGIONAL SURVEY SECTION of the Commonwealth Scientific and Industrial Research Organization, Canberra, to be a member of a scientific unit conducting potentiality surveys of undeveloped regions—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 570/38 (June 25).

Senior Research Fellow in Physics, at the University of New England, Armidale, New South Wales, Australia, to undertake a programme of experimental or theoretical research, preferably, but not necessarily, in the field of ionization and discharge physics or of solid state physics—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, June 27).

Demonstrator or Lecturer in the Department of Zoology—The Dean, Medical College of St. Bartholomew's Hospital, West Smithfield, London, E.C.1 (June 30).

Plant Breeder (Fruit), Senior Scientific Officer or Scientific Officer grade, at the Research Station, Long Ashton, Bristol—The Registrar and Secretary, The University, Bristol 8 (June 30).

Professor of Geology at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, June 30).

Senior Lecturer (with a good honours degree and research experience, preferably in plant pathology, systematic botany or genetics) in Botany, at the Imperial College of Tropical Agriculture, Trinidad, B.W.I.—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W.C.2 (June 30).

Technical Officer (with an honours degree in electrical engineering, physics or chemistry, and experience in the design and construction of electronic apparatus for the study of chemical problems, with special reference to flash discharges and micro-wave spectroscopy) in the Department of Physical Chemistry—Dr. F. B. Kipping, University Chemical Laboratory, Pembroke Street, Cambridge (July 1).

Assistant Lecturer, Grade B (preferably with some teaching, industrial and/or research experience) in the Department of Physics—The Principal, Royal Technical College, Salford 5.

Assistant Lecturer (graduate in chemistry or biochemistry and preferably with experience in the food industry)—The Principal, National College of Food Technology, Cranwood Street, City Road, London, E.C.1.

Chair of Physiology at Makerere College (The University College of East Africa)—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1.

Chemist, Scientific Officer or Senior Scientific Officer grade (with an honours degree), to work in a team investigating fundamental aspects of the structure of certain dielectric materials—The Director of Research, British Ceramic Research Association, Queens Road, Penkhull, Stoke-on-Trent.

Departmental Demonstrator (with a good degree in any branch of engineering and preferably with postgraduate experience) in Engineering Science, for duties which include both lecturing and undergraduate instruction in the laboratories—Professor of Engineering Science, 19 Parks Road, Oxford.

Experimental Officer (with at least H.S.C. in science subjects or equivalent qualifications, and preferably with some experience in physics, electronics or spectrochemistry or any combination of these) in the Spectroscopy Group, for work which includes spectrochemical analysis with emphasis on the development of new techniques (for example, electronic direct recording) and spectro-physical examination of the transuranic element spectra—The Establishments Officer, United Kingdom Atomic Energy Authority, A.E.R.E., Harwell, Didcot, Berks, quoting 2/103/298.

Government Chemist (with a degree in chemistry of a British university) in the Medical Department of the Gold Coast Local Civil Service, for the analysis of foods, drugs, wines and spirits, textiles, and pathological samples, including poisons—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.117/13/012.

International Wool Secretariat Research Fellow (with chemical or biochemical qualifications) to undertake work on the physical chemistry of the wool fibre—The Principal, Technical College, Bradford.

Lecturer in Education at the Nigerian College of Arts, Science and Technology—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1.

Lecturer in Zoology at the University of Malaya, Singapore—The Secretary, Inter-University Council of Higher Education Overseas, 1 Gordon Square, London, W.C.1.

Research Assistant (Ph.D. standard), for work on reaction kinetics at gas-solid interfaces—Dr. F. C. Tomkins, F.R.S., Imperial College, London, S.W.7.

Research Assistants (2) in Physical Chemistry—The Clerk to the Governors, South-West Essex Technical College and School of Art, Forest Road, Walthamstow, London, E.17.

Statistician (preferably with experience of field trials)—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

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South African Council for Scientific and Industrial Research. National Building Research Institute. Housing for the Urban Bantu—a Problem in Whole Engineering. By J. E. Jennings. (Pretoria: South African Council for Scientific and Industrial Research, 1954.) [153

Smithsonian Miscellaneous Collections. Vol. 123, No. 7: Early Cenozoic Vertebrates in the Red Conglomerate at Guanajuato, Mexico. By Carl Fries, Jr., Claude W. Hibbard and David H. Dunkle. (Publication 4181.) Pp. ii+25+1 plate. (Washington, D.C.: Smithsonian Institution, 1955.) [153

Yale Medical Library. Annual Report including Report of the Historical Library, 30 June 1954. Pp. 32. (New Haven, Conn.: Yale Medical Library, 1954.) [153

Bulletin of the Museum of Comparative Zoology at Harvard College. Vol. 112, No. 2: Deep Water Elasmobranchs and Chimaeroids from the Northwestern Atlantic Slope. By Henry B. Bigelow and William C. Schroeder. Pp. 1+37–88. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1954.) [153

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